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Alternative Wastewater Treatment: Promoting Health and Preserving the Environment

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ABSTRACT

The present study reviews sustainable alternatives for effluent treatment, comparing the conventional method and Nereda technology. It is believed that activated sludge does not promote adequate purification of the effluent, which can negatively impact the health of society and contribute to the degradation of water resources. However, Nereda technology is a sustainable approach that consists of a biological treatment using aerobic granular sludge. This produces extra purified effluents with little or no addition of chemicals in some cases. 28 references were analyzed, which indicated the most efficient alternative treatment in broad aspects, such as sedimentation and nutrient removal. In this way, technology offers greater health security and sustainability, ensuring the preservation of the environment. However, expanding it around the world is still a challenge, considering the factors that hinder its implementation.

Keywords: Nereda technology; Activated sludge; Toxic loads; Pathogenic microorganisms; Water pollution

INTRODUCTION

More sustainable alternatives that aim to protect life, preserve essential elements and the environment as a whole, are a constant focus for the development of new technologies in the field of basic sanitation [1]. This can be defined as a set of actions aimed at preventing health and the environment, through the management of solid waste and water resources [2].

Wastewater resulting from everyday activities, such as washing clothes and preparing food, is composed of organic matter, microorganisms and chemicals. Due to this composition, wastewater can favor the spread of microorganisms and substances harmful to health, in addition to contributing to the pollution of river basins and being associated with an increase in Waterborne Diseases (WWD). Therefore, the purification of effluents is essential to guarantee the health of the population and the preservation of the environment [3].

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In Brazil, around half of the population does not have access to sewage treatment, with the tributary being discharged daily into rivers due to the lack of local sewage treatment stations (ETEs) or unfinished stations due to lack of resources, as is the case with city of Governador Valadares in Minas Gerais [4].

Despite the precarious scenario, the new sanitation legal framework, sanctioned in federal law 14.026/2020 approved in July 2020, its objective is to guarantee the universalization of treatment and enable the opening of the sector to the private sector. Furthermore, the national water and basic sanitation agency (ANA) and Atlas Esgoto aim to regulate and standardize the service, collaborating in the issuance of reports and reference standards [5].

In the context of sanitation measures that aim to ensure access to effluent treatment services, it is necessary to address the deficiencies of the conventional activated sludge treatment method, which is widely used in the country as standard. To achieve this, it is essential to find solutions to these deficiencies or consider adopting new approaches.

Nereda technology developed in the Netherlands appears as a promising and sustainable alternative with the purpose of optimizing effluent treatment through biological processes, with the benefit of obtaining an extra purified effluent.

Considering that the quality of the final effluent can have negative impacts on health and the environment, it is essential to collect information on the limitations of conventional treatment and present Nereda technology as an alternative [6].

The aim is to compare conventional treatment with Nereda technology, evaluating which is most effective in promoting health and preserving the environment. Furthermore, we seek to identify the factors that limit the expansion of technology in Minas Gerais and the country [7].

MATERIALS AND METHODS

Since studies will be brought together to integrate the results, the work in progress involves a systematic review, drawn up from the selection of 28 scientific articles and government data [8]. To define the theme, the impact of effluent quality on health and the environment was considered. The bibliographical research took place in the Scielo, Virtual Health Library and Google Scholar databases, using the descriptors: Biological sludge; domestic sewage; conventional treatment; aerobic granular sludge; waterborne diseases. To delimit the subject, we apply the respective filters: Period, language, strings (AND) and full texts [9]. Government data was obtained from the Federal Government platform. The inclusion criteria establish that the articles considered must be published within a period of 10 years, with the exception of classic articles that are essential for carrying out the work. Furthermore, the full texts of the articles must be available for download. The exclusion criteria used in this study consists of removing outdated articles that are not relevant to answering the research questions and objectives. And also mono-graphs, doctoral theses, dissertations and course completion work [10].

RESULTS AND DISCUSSION

The rupture of the mining tailings dam belonging to the company ValeS. In Brumadinho Minas Gerais, was a tragic event that occurred in 2019 that resulted in the contamination of river basins and consequently, health problems for the population. Furthermore, the quality of the water that reaches residents is currently questionable and the overload of heavy metals is evident [11].

The degradation of water resources favors the dissemination of microorganisms and contributes to the prevalence of the epidemiological scenario of morbidity/mortality due to fecal-oral transmission diseases such as bacterial, viral and parasitological infections [12].

According to a study carried out in 2019 by Instituto Trata Brasil, around 273 thousand hospitalizations for DVH were recorded, revealing that the endemic regions are those that do not have sanitation services, highlighting the correlation (**Figure 1**). The incidence was 13 cases per 10 thousand inhabitants, which generated an expense of approximately 108 million rea is according to DataSUS [13].

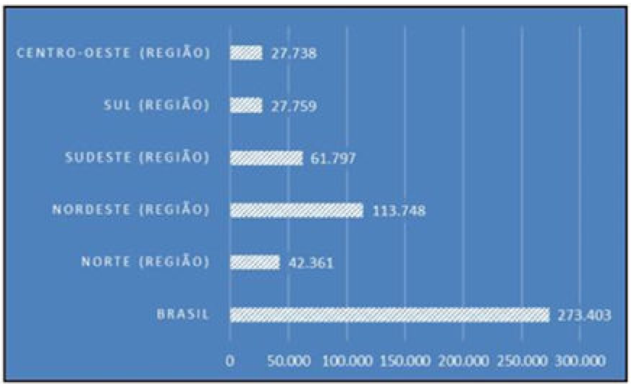

Figure 1: Hospitalizations due to waterborne diseases (DVH) associated with the lack of sanitation in 2019.

Conventional treatment with activated sludge (LA) is a biological method for treating effluents, and is widely disseminated and consolidated in Brazil. Purification is divided into the following steps: Grating, desandering, aeration and decantation [14].

In general, purification consists of separating the effluent into solid and liquid phases, through the removal of organic matter and nutrients, using biological sludge. And the process occurs in two decantation stages. However, the treatment is partially biological, and requires the addition of several chemical products.

Still referring to decantation, it is the determining stage of the treatment, as it removes nutrients such as nitrogen, phosphorus and carbonaceous matter that are harmful to health. Likewise, better sedimentation determines water quality, which can be seen at a macroscopic level [15].

Although conventional treatment with LA is widespread in the country, it still shows little efficiency in sedimentation due to its floccular structural form, which directly affects the quality of the final effluent. Another point is the model of the reactors used, which also disadvantages the process. The low quality of the effluent can generate epidemiological demands, as is the case with the incidence of multi-resistant bacteria, which can become fatal forhumans [16].

In this regard, a study based on quantifying bacteria resistant to ampicillin and chloramphenicol present in raw sewage and final effluent, observed that a significant amount remains after treatment with LA, however, it is still lower than in the treatment using reactors anaerobic filters (UASB) followed by Biological Percolating Filters (FBP), confirming the harm of the treatment currently used.

Aiming to solve the deficiencies of conventional treatment, Nereda technology, developed in the Netherlands by Royal Haskoning DHV, offers more effective ways to treat effluents [17].

The technology is based on biological water purification, using aerobic granular sludge (LGA). This is made up of selected and cultivated microorganisms *in vitro* for a period of approximately 80 days until its maturation, the result is a three-dimensional structure of greater dimension and density called “granule”.

A granular structure is considered when it is formed from the physical interaction between bacteria and bacteria under the action of attraction and electrostatic forces, reaching a dimension above 0.2 mm. The most notable characteristics of the granules are: XThree-dimensional structure, high density, high biomass retention capacity and nutrient removal [18].

Regarding the three-dimensional structure, it is noteworthy that the low diffusion of oxygen in the granule allows the coexistence between the aerobic and anaerobic zones, enabling a variety of biological processes to occur simultaneously.

One example is the genre *Pseudomonas*, it is Esiguo-bacterium which under anaerobic conditions act as nitrifiers, denitrifiers, acting in the biological removal of phosphate.

The density of the granules is greater than in the LA flocculated structure, enabling better decantation in a short period, **Figure 2**. The characteristic may be associated with a communication mechanism “whose sensing, which consists of responding to cell density through gene regulation [19].

Figure 2: Comparison of sedimentation between Nereda and conventional, respectively.

There are some factors that can contribute to the stability and density of the granules, such as the aeration rate and rising speed that promote the synthesis of Exopolysaccharides (EPS) by bacteria, giving them characteristics that increase efficiency in sedimentation and removal of nutrients.

LGA is grown in Sequential Batch Reactors (SBR), but it is also possible in other systems. The granulation process is said to be complete when more than 80% of suspended solids are removed [20].

The technology is forged by valves and automated systems that offer more safety during treatment, with its greatest advantage being the ability to treat a greater flow in a smaller area, as shown in **Figure 3**. Furthermore, it offers the same standard of treatment on a large and small scale, serving cities of up to 1,600 inhabitants.

Figure 3: Comparison of flow capacity versus area between Nereda and conventional.

In Brazil, ETE Deodoro was the first station adapted with Nereda technology in Rio de Janeiro in 2016, being opened by Zona Oeste Mais Saneamento with the main objective of reducing the volume of domestic sewage released into the rivers of the West Zone and the Guanabara Basin. It is considered the largest plant in the world and the only one in Latin America with the capacity to serve around 432 thousand people and treat a volume of 64.8 thousand m^3 per day. Since its implementation, the technology has been licensed by the company BRK Ambiental, remaining in force to this day.

An evaluation carried out at the Deodoro estacion, showed a high removal of nutrients, and the quality of the effluent is associated with the efficiency of the RBS-LGA in promoting the formation of granules and better decantation, **Table 1**. With regard to sustainability, be careful with the health and environment, technology has proven to be superior to conventional treatment.

Table 1: Assessment of carbonaceous matter removal by RBS-LGA at ETE Deodoro DQO.

DQO total	Total non-influent COD	Ammoniacal nitrogen	Nitrite in the reactor	Phosphorus removed	Phosphorus in the final tributary
85%	22 mg. L^{-1}	1.6 mg. L^{-1} 90%	0	55%	1 mg. L^{-1}

A comparative analysis of sedimentation between the reactors of the conventional model and technology indicated that the RBS with LGA, presented better results in decantation when compared to the University of Cape Town (UTC) system normally used in the conventional with LA.

Regarding the case of the dam collapse in Brumadinho, there is currently a limitation to the expansion of Nereda in some regions of the state of Minas Gerais, due to the sensitivity of the granular structure to toxic loads. But beyond that, the need to modify existing installations to accommodate the technology remains its main bias.

Furthermore, it must be considered that the dumping of untreated or low quality effluents into rivers can make the process in water treatment stations unfeasible, as it makes their purification difficult due to excess pollutants, which requires the excessive use of surfactants and other chemical products that cause harm to health.

Regarding the correlation between the rates of hospital admissions and the lack of treatment or its low quality, there is also a scenario of prevalence of Infectious Parasitic Diseases (IPD) in the same regions considered most affected in the country, Southeast and Northeast, both in places that there are ETEs as in places without effluent treatment.

Even though there is a long-term advantage in adopting the technology due to its excellent flow/area ratio, treating a larger volume in a small space as seen in **Figure 1**.

On the other hand, up to 53% of the reactors are smaller in relation to the conventional one, but, due to the low diffusion of oxygen in the granules, greater energy expenditure occurs during the aeration process, reaching up to 15% increase, also resulting in a greater chemical oxygen demand.

The removal rates of carbonaceous matter promoted by ETE Deodoro represented in **Table 1**, show us that even though the technology is highly effective in this regard, there is a greater COD due to the low diffusion of the element in the granules, and a great instability in the structure, not occurring in the conventional model. However, the removal rates of nitrogenous and phosphoric compounds, which are of high relevance for the prevention of human health, demonstrated an excellent result.

However, a deficiency is found in the synthesis of LGA itself due to its inoculation method and substrate composition, which can compromise its stability and effectiveness, affecting large-scale reproduction. However, granule formation occurs naturally from raw sewage without inoculation.

However, there are solutions that aim to increase stability, such as using diluted sanitary sewage, cultivating microalgae creating photo-granules, using non-tubular reactors, mechanical aeration and storage at 4°C. Such measures have proven to be favorable to these structures, in addition to promoting stability and greater decantation speed, it reduces COD.

Comparing the two treatment alternatives, Nereda presented disadvantages in relation to the conventional one, such as: Low stability of the LGA, high COD, high implementation cost, sensitivity to toxic loads and the need for pre-treatment and modification of the facilities. And the disadvantages of the conventional model are: Low sedimentation and removal of carbonaceous matter, poor quality of the final effluent and the need for a large geographic space to accommodate it.

Aiming to compare the place where the technology was created with Brazil, it is observed that in the Netherlands there is a large investment in innovative technologies. Nereda, created especially to enhance water quality and offer quality of life for the population. However, the good health practices of Dutch society contribute in this regard, as they are crucial measures to offer a highly efficient service.

CONCLUSION

It was concluded that Nereda technology is a more effective and safe alternative for treating effluents, compared to the conventional model. Promoting health and preserving the environment. However, it proved to be unfeasible to treat water resources that have a toxic load, such as contamination with mining waste. Furthermore, the high cost of implementation, the need for pre-treatment and modification of the facilities, seem to be the most preponderant limitations. Therefore, its expansion in countries with low socio-environmental and economic conditions is still a challenge.

REFERENCES

1. Araujo J (2019) Aerobic granulation under different rising speeds treating diluted domestic sewage. Apesb Magazine, Recife. 17-24.
2. ANA (2017). National water and basic sanitation agency. Atlas sewage: Cleaning up river basins. Brasilia: Federal Government.
3. Alves C (2018) Biological nitrogen removal in wastewater: A review from conventional to modern processes. Ibero-Am J Environ Sci. 1-14.
4. Alves G (2021) Health and sanitation in Brazil: A narrative review on the association of basic sanitation conditions with waterborne diseases. Res Soc Dev. 1-12.
5. BRK Environmental (2018) Nereda technology-treatment of sanitary sewage with aerobic granular biomass. 7th National water meeting, Sao Paulo, Brazil.
6. Brazil (A) Federal government (2023) New sanitation regulatory framework. Ministry of environment and climate change.
7. Brazil (B) Federal government (2021) Almost 50% of Brazilians does not have access to sewage networks. Agencia Brasil.
8. Campos HCG (2022) Influence of different mixing modes on the development of granular biomass and algal-bacterial consortium in sequential batch reactors using low organic load synthetic sewage. ATTENA-UFPE Digital Repository. Federal University of Pernambuco, Recife.
9. de Kreuk MK, Heijnen JJ, van Loosdrecht MC (2005) Simultaneous COD, nitrogen, and phosphate removal by aerobic granular sludge. Biotechnol Bioeng. 90(6): 761-769.
10. Gallego J, Schmechel M, Pereira D (2016) Relationship between basic sanitation in Brazil and population health

from the perspective of hospital admissions for waterborne diseases.
11. Guedes A (2017) Water treatment in the prevention of waterborne diseases prevention. Integradas de Patos Med Course. 2(1): 452-461.
12. He Q, Chen L, Zhang S, Wang L, Liang J, et al. (2018) Simultaneous nitrification, denitrification and phosphorus removal in aerobic granular sequencing batch reactors with high aeration intensity: Impact of aeration time. Bioresour Technol. 263:214-22.
13. Hou C, Shen J, Zhang D, Han Y, Ma D, et al. (2017) Bioaugmentation of a continuous-flow self-forming dynamic membrane bioreactor for the treatment of wastewater containing high-strength pyridine. Environ Sci Pollut Res Int. 24:3437-3447.
14. Lima J, Santos EVM, Filho HAS, Sousa JT, Haandel ACV (2014) Assessment of the sediments ability of granular and flocculent biomass in activated sludge systems. Holos. 3:319–331.
15. Liu Y, Wang ZW, Qin L, Liu YQ, Tay JH (2005) Selection pressure-driven aerobic granulation in a sequencing batch reactor. Appl Microbiol Biotechnol. 67:26-32.
16. Machado FC, Quirino JM (2021) Aerobic granular sludge: A comparison with activated sludge, technological magazine of the Santa Ursula University, Botafogo. 4(2): 24-37.
17. Souza MM, Santos AS (2016) Drinking water, wastewater and sanitation in Brazil and in The Netherlands within the Dutch Visitation Program-DVP: Dutch visitors programme. Sanitary Environ Eng. 21:387-395.
18. Machado EC (2020) Detection and quantification of bacteria resistant to the antibiotics ampicillin and chloramphenicol in domestic sewage treatment plants. Sanitary Environ Eng. 25(6):847-857.
19. Mata AMT, Pinheiro HM, Lourenco ND (2018) Development of an aerobic granule bioreactor for treating synthetic wastewater and reactivating the system after prolonged shutdown. Sanitary Environ Eng. 23(4): 757–766
20. Nereda Technology (2023) Wastewater treatment solutions by Royal Haskoning DHV. The Netherlands.