UFSM

CIÊNCIA e NATURA

ISSN 2179-460X
Acesso aberto

Ci. e Nat., Santa Maria, v. 44, Ed. Esp. VI SSS, e25, 2022 • https://doi.org/10.5902/2179460X68834
Submitted: 8/12/2021 • Approved: 9/12/2021 • Published: 6/4/2022

Special Edition

Small-Scale Wetland Model for Synthetic Sewage Treatment

Wetland construído de bancada para tratamento de esgoto sintético

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ABSTRACT

The present research has the objective of verifying the efficiency of a small-scale wetland for synthetic sewage treatment. The experiment consisted of three systems in series, where each system consisted of a WC without saturation (F1A, F2A and F3A), these are on the top of the laboratory bench, and a second WC (F1B, F2B, F3B), with saturation that was at the bottom of the bench. Systems were also developed with the presence of macrophytes (Cyperus alternifolius) (FM1B, FM2B and FM3B), implanted only in systems with saturation for comparison between them. It was found that synthetic sewage had a significant reduction in the parameters of COD (71.74%), BOD (29.09%), ammoniacal nitrogen (87.15%), total phosphorus (88.77%), nitrate (82.85%), nitrite (76.71%), and total suspended solids (94.02%), after its percolation through the WC system. Through one-way analysis of variance (ONE-WAY ANOVA), followed by Tukey's Post Hoc test, it was found that the parameter in which there was less significant reduction in the system was BOD, with no significant differences occurring between systems without and with macrophytes. Thus, it was possible to assess that the proposed system contributed positively to the parameters analyzed, confirming its efficiency against synthetic sewage treatment.

Keywords: Constructed wetland; Wastewater treatment; Sanitation

RESUMO

O presente trabalho tem o objetivo de verificar a eficiência de um Wetland Construído de bancada para o tratamento de esgoto sintético. O experimento foi composto por três sistemas em série, onde cada sistema era composto por um WC sem saturação (F1A, F2A e F3A), estes ficam na parte superior da bancada do laboratório, e por um segundo WC (F1B, F2B, F3B), com saturação que ficava na parte inferior da bancada. Ainda foram desenvolvidos sistemas com a presença de macrófitas (Cyperus alternifolius) (FM1B, FM2B e FM3B), implantadas apenas nos sistemas com saturação, para comparação entre eles. Nesse sentido, verificou-se que o esgoto sintético obteve redução significativa nos parâmetros de DQO (71,74%), DBO (29,09%), Nitrogênio Amoniacal (87,15%), Fósforo Total (88,77%), Nitrato (82,85%), Nitrito

(76,71%) e Sólidos Suspensos Totais (94,02%), após sua percolação pelo sistema de WC. Através de análises de variância de uma via (ONE-WAY ANOVA), seguido do teste Post Hoc de Tukey, constatou-se que o parâmetro em que houve redução menos significativa no sistema foi o de DBO, não ocorrendo diferenças significativas entre os sistemas sem e com macrófitas. Assim, foi possível avaliar que o sistema proposto contribuiu de forma positiva nos parâmetros analisados, confirmando sua eificiencia frente ao tratamento de esgoto sintético.

Palavras-chave: Wetland Construído; Tratamento de Efluentes; Saneamento Básico

1 INTRODUCTION

Currently, several technologies for the treatment of water resources specifically for the recovery and maintenance of chemical, physical, and biological characteristics have been disseminated. In the last 20 years, the interest and potential of studies on natural biological systems to assist in water purification has increased. (ALMEIDA *et al*., 2005). Constructed wetlands (CWs) are a wastewater treatment technology that is an improved version of processes seen in natural ecosystems such as swamps and mangroves. (ZANELLA, 2008).

Wetlands are also known as peatlands, artificial wetlands, planted beds, beds with macrophytes, planted filters, filter gardens, in addition to the international denomination of treatment wetlands or constructed wetlands. They are based on physical, chemical, and biological mechanisms. (VON SPERLING, 2014).

The first study relating the use of a CW for the treatment of wastewater was in the 1950's in Germany, at the Max Planck Institute. Through a survey carried out by Cooper (2007), there are more than 1200 systems of this type for the treatment of domestic sewage in the United Kingdom alone. In Brazil, the first reports of the use of wetlands for improvements in water quality and pollution management took place in the early 1980s by researchers Salati and Rodrigues. (SALATI JR.; SALATI; SALATI, 1999).

The studies started from attempts to use constructed wetlands with an artificial lake with water hyacinth near a stream with a high load of pollutants. Later on, Rodolfo and Lourde (1999) conducted a research where they called the treatment of wastewater from homes as phytopedological processes, which were nothing more than CWs with the use of coarse sand. These had a high permeability as filtering soils and support for aquatic plants such as reeds and cattails.

The experiences regarding CWs in the country intensified from the year 2000. This was due to the application of the system to treat different wastewaters spread over several states with different arrangements and forms, in addition to the most varied filtering materials and aquatic plants used. (SEZERINO *et al*., 2015). According to a survey by PNSB in 2008, there were 109 constructed wetlands in Brazil with applications for the treatment of domestic sewage, 48 of which were located in the Southeast region, 28 in the South region, 33 in the Northeast region, 4 in the North region, and 2 in the Midwest region. (IBGE, 2010). Nevertheless, it is believed that this number is already bigger due to research carried out by several universities in the country and by companies specialized in technology.

In Mato Grosso State (MG), one of the first studies focused on constructed wetlands was carried out in 2012, with regard to the post-treatment of effluents from maturation ponds. This was conducted by the researcher Vanusa Ormonde at the Universidade Federal do Mato Grosso in Cuiabá (MG) (ORMONDE, 2012). Subsequently, research conducted in the state has advanced but with little momentum and visibility.

In general, these systems are used to treat the most varied types of effluents, such as domestic sewage, both at secondary and tertiary levels, rainwater, industrial effluents, and leachate treatment. (SCHARF *et al*., 2006, p.3). The system has advantages such as the low cost of implantation, operation, and maintenance, when compared to conventional ones. Furthermore, Brazil is one of the countries that enjoys climatic and environmental conditions suitable for constructed wetlands. Another relevant point is that the country has a deficit in the treatment of wastewater. (VALENTINE, 2003).

The constructed wetland systems have effective results in removing organics and suspended solids. They also allow for the removal of nitrogen which can be maximized by combining various types of wetlands. (CUNHA *et al*., 2009). Wetlands are built systems that help to improve water quality through biological, chemical, and physical mechanisms; these processes occur in the system where the roots and stems of plants have the ability to filter uncommon components inserted in the medium such as heavy metals, as well as ion exchange and adsorption in the aqueous medium.

This environment serves as a habitat for bacterial populations that contribute to the reduction of BOD - Biochemical Oxygen Demand. The waters without turbulent movements provide the sedimentation of suspended solids and the aquatic plants soften the microclimate intemperate such as temperature, insolation, and winds (U.S. ENVIRONMENTAL PROTECTION AGENCY, 1998). It is observed that the wetland with its flooded areas can be called a natural wetland.

CWs are systems that can treat various types of effluents, such as domestic sewage, rainwater, and effluents from sanitary and industrial landfills (ORMONDE, 2012). Expansion of researches aims to identify and improve the function of each component that acts in the treatment such as filter material, flow used, macrophytes, maximum influent loading, purification, oxygen transfer, biofilm formation structure, and the useful life of the system (SEZERINO, 2006).

Even with the increase in studies in this area, knowledge about CWs is still fragmented and with little standardization, especially in the intended study region (Matogrossense swampland.). Thus, the aim of this research is to study the behavior of a small-scale Westland model for the treatment of synthetic sewage produced in the laboratory of the Universidade do Estado de Mato Grosso in Cáceres City, in comparison with effluent from a Sewer Treatment Station (STS), in order to verify its efficiency regarding physical-chemical parameters.

The specific objectives are divided into distinct steps: (a) to propose the design of a vertical flow bench WC for the treatment of synthetic sewage produced in the UNEMAT laboratory Cáceres City – MT; and (b) evaluate physical-chemical parameters such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand

(COD), ammonium, total phosphorus, nitrate, nitrite, and total suspended solids after treatment by the small-scale CW.

2 METHODOLOGY

The study was developed at the North Pantanal Ichthyology Laboratory – LIPAN of the Universidade do Mato Grosso State (UNEMAT), Jane Vanini Campus Jane Vanini in Cáceres City. A bench-scale constructed wetland system was developed for the treatment of synthetic sewage produced in the laboratory.

The experiment consists of three systems in series, where each system is composed of a CW without saturation (F1A, F2A, and F3A); these are on the top of the laboratory bench. There was also a second CW (F1B, F2B, and F3B) with saturation that is at the bottom of the bench. Systems were also developed with the presence of macrophytes (Cyperus alternifolius) (FM1B, FM2B and FM3B) implanted only in systems with saturation for comparison between them (Figure 1).

Figure 1 – CE systems in series, being a) A1 system, b) A2 system, and c) A3 system

Source: Authors, 2022

2.1 Sizing of Treatment Units

The bench-scale CW systems were dimensioned according to the methodology employed by Sezerino & Philippi (2003). For this, 6 plastic drums of

50 liters were used reproducing 3 CW systems with dimensions of 0.39 m wide by 0.32 m long and 0.55 m high (Figure 2).

Figure 2 – Canisters with dimensions of 0.39x0.32x0.55 m

Source: Authors, 2022

In the experiment, synthetic sewage was reproduced based on the composition of the sewage found in the STS of the Tangará da Serra City (MT). This is because it was a city with easy access to comparative data from the sewage treatment plant. In order to polish the CW, the methodology of Sezerino & Philippi (2003) was adopted, reaching a flow rate of 10 liters per day which is an ideal system feed flow to test its efficiency and a load of 16 g/m²d of OBD, since the maximum value allowed for the load is 20 g/m²d."

2.2 Synthetic Sewage

The basic composition of synthetic sewage was adapted from Torres (1992) and Araújo (2014) as shown in table 1.

Table 1 – Organic Composition of Components

Organic fraction	**Bod percentage (%)**
Proteins	21
Carbohydrates	47
Lipids	36

Source: Authors, 2022

The composition of the synthetic substrate for the production of 5 liters of sewage with a BOD of 500 mgO2/ are shown in table 2.

Table 2 – Synthetic substrate composition

Organic compounds	**Concentration**
Soy extract	6.20 g
Sucrose	1.40 g
Commercial starch	2.20 g
Vegetable oil	1.00 ml
Detergent	2.00 g
Sodium bicarbonate	4.00 g

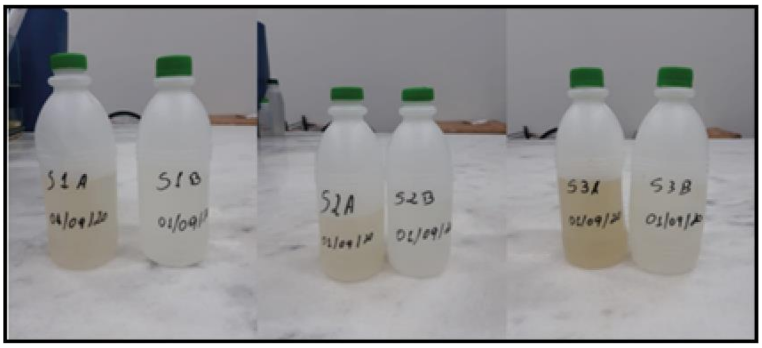
Source: Adapted from Torres, 1992 and Araújo, 2014

Synthetic sewage was prepared every day, with 5 liters of synthetic sewage being produced in the morning (7 hours) and 5 liters in the afternoon (17 hours) for each, totaling a production of 15 liters per shift i.e. 30 liters per day to promote the feeding of the systems.

Thus, sewage was always placed in the F1A, F2A and F3A systems of each set of drums; collection was carried out and the rest of the effluent passed through the systems (F1B, F2B, and F3B). Afterwards, the macrophytes were implanted in the systems (FM1B, FM2B, and FM3B) that were at the bottom of the bench.

The feeding took place since the 26th of August (except weekends and holidays). The samples were collected every 10 hours and stored in containers with the name of the sample, as well as the date collected, and then stored in a refrigerated environment until the time of analysis. In this way, the characteristics of the effluents were preserved without compromising the efficiency of the results (Figure 3).

Figure 3 – Samples collected on September 1st



Source: Authors, 2022

2.3 Bench-scale CW Stages of Construction

In Figure 4, the steps in the assembly of the bench-scale CW are presented. The first phase consisted of cutting the drum cover with a hammer drill then cutting the 25 mm diameter PVC sewage pipes into 25 cm pieces. Subsequently, holes were made using a 10 mm drill in the pipe with spacing of 5 in 5 cm, in the shape of a T (pipe joint made with a 25 mm).

Figure 4 – a) Section of the cylinder cover; b) PVC pipe cutting; c) T-connection of the pipe; 5 cm spacing holes in the pipe

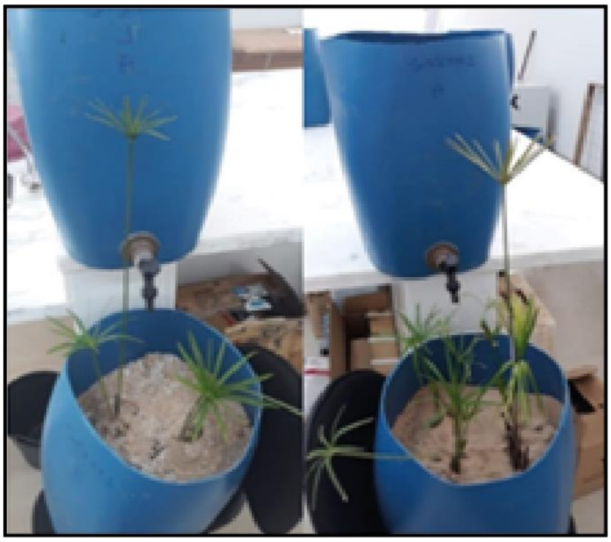
Source: Authors, 2022

After the drums had the pipe and faucets installed, the first layer of 20 cm with gravel number 1, the second layer with 5 cm of sieved stone powder (Figure 5), and the third layer of 10 cm with sand were incorporated into the system (Figure 6).

Figure 5 – Layer of gravel #1 and sifted stone dust

Source: Authors, 2022

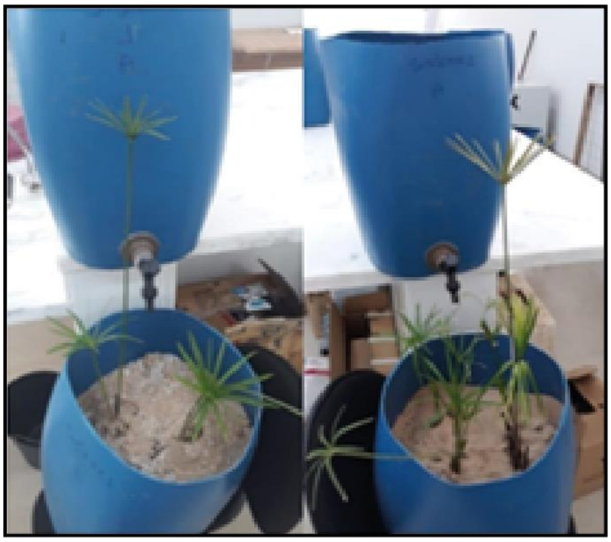
Figure 6 – Medium sand layer



Source: Authors, 2022

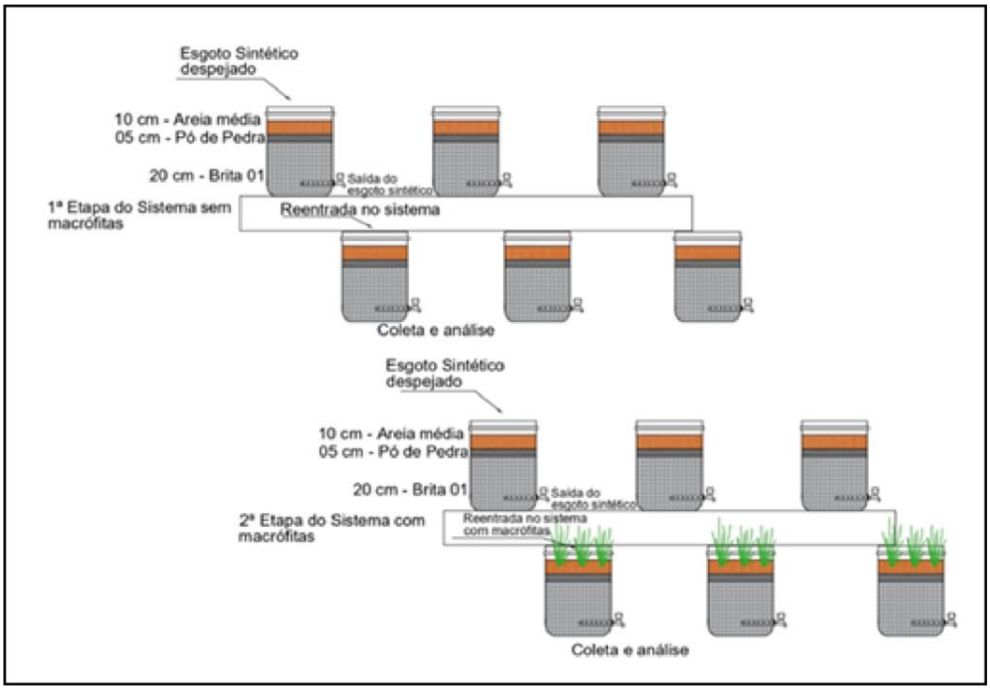
The implementation of macrophytes took place in the second phase of the experiment (Figure 7), on September 24, 2020. They were introduced 10 cm into the sand layer. Three macrophyte seedlings were planted in the systems, then named (FM1B, FM2B, and FM3B). Collections after macrophyte implantation took place from September 25th to October 1st. Figure 8 presents a schematic drawing of the system.

Figure 7 – a) Systems with aquatic macrophytes; b) Systems with aquatic macrophytes



Source: Authors, 2022

Figure 8 – Constructed Wetland System Schema



Source: Authors, 2022

2.4 Analysis of physical-chemical and statistical variables

As for the physicochemical analyses, the parameters of ammoniacal nitrogen, total phosphorus, nitrate, nitrite, BOD, COD, and total suspended solids were analyzed. Analyzes were based on the Standard Methods for Examination of Water and Wastewater (2005).

To compare the values of the physicochemical parameters analyzed between systems and data presentation, one-way analysis of variance (ONE-WAY ANOVA) was performed, followed by Tukey's Post Hoc test. The results obtained were presented in tables for better understanding.

3 RESULTS

3.1 Chemical Oxygen Demand

After the synthetic sewage passed through the CW system, there was a significant reduction of COD in the WC. In F1A, F2A, and F3A there were reductions of 57.08%, 58.31%, and 58.40%, respectively. After passing through the F1B, F2B, and F3B systems, there was an improvement in the results of 71.37%, 71.74%, and 71.55%. In the filters with macrophytes FM1B, FM2B, and FM3B, the removal was 71.73%, 71.6%, and 70.83%, as shown in Table 3.

Table 3 – Results of COD analysis

Statistical parameter	**Affluent**	**Effluent**								
COD		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	205,23	90,82	88,89	89,97	60,95	60,89	60,45	60,12	60,83	61,71
Minimum	205,10	86,51	85,57	85,40	58,77	58,01	58,40	58,02	58,37	59,62
Maximum	205,30	92,52	90,83	93,10	63,52	64,03	64,15	63,72	62,95	64,03
Standard deviation	0,09	1,94	1,81	2,32	1,37	1,88	1,80	1,57	1,44	1,44
Efficiency Percentage		57,08%	58,31%	58,40%	71,37%	71,74%	71,55%	71,73%	71,56%	70,83%

Source: Authors, 2022

3.2 Biochemical oxygen demand

In F1A, F2A, and F3A, the efficiency was 22.66%, 22.57%, and 21.05% respectively as shown in Table 4. In F1B, F2B, and F3B the reduction was 27.87%, 29.09 %, and 29.04%, suggesting a reduced increase in efficiency for systems without saturation. And in systems with macrophyte, there was no increase and reduction as for filters F1B, F2B, and F3B. Thus, the results in FM1B, FM2B, and FM3B were 27.70%, 27.41%, and 27.22%.

Table 4 – Result of BOD analysis

Statistical parameter	**Affluent**					**Effluent**				
BOD		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	104,32	83,97	84,54	85,19	78,57	77,43	76,80	77,59	77,82	78,10
Minimum	104,20	80,81	80,91	82,50	75,37	74,10	74,15	75,55	75,85	76,05
Maximum	104,50	88,17	87,68	88,01	80,78	80,55	79,13	80,33	80,15	79,86
Standard deviation	0,09	2,35	2,49	1,72	1,86	2,34	1,55	1,37	1,20	1,37
Efficiency Percentage		22,66%	22,57%	21,05%	27,87%	29,09%	29,04%	27,70%	27,41%	27,22%

Source: Authors, 2022

3.3 Total suspended solids

The results of total suspended solids showed a high reduction in the passage through the F1A, F2A, and F3A systems with 89.87%, 89.50%, and 89.55% reduction. Subsequently, the passage of the effluent through F1B, F2B, and F3B resulted in an increase in the reduction of the parameter, reaching 93.29%, 94.02%, and 94.00%. The CWs FM1B, FM2B, and FM3B reached 93.63%, 92.98%, and 93.16% as shown in Table 5.

Table 5 – Results of Total Suspension Solids Analysis

Statistical parameter	**Affluent**					**Effluent**				
Total Suspension Solids		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	38,43	5,34	5,91	5,31	3,69	3,13	3,37	3,44	3,49	3,33
Minimum	38,40	3,90	4,04	4,02	2,58	2,30	2,31	2,45	2,70	2,61
Maximum	38,50	6,38	7,42	7,45	4,44	4,32	4,01	4,50	4,40	4,49
Standard deviation	0,05	0,81	1,12	1,32	0,72	0,67	0,54	0,64	0,64	0,62
Efficiency Percentage		89,87%	89,50%	89,55%	93,29%	94,02%	94,00%	93,63%	92,98%	93,16%

Source: Authors, 2022

3.4 Nitrite

Regarding the nitrite results, the CW system showed little variation between the systems. In F1A, F2A, and F3A, the efficiency was 53.42%, 53.42%, and 44.52% as shown in Table 6. In the CW F1B, F2B, and F3B, this was improved, reaching 60.27%, 67.12%, and 66.43% respectively. In the systems with FM1B, FM2B, and FM3B macrophyte, an efficiency of 76.71% was achieved in both.

Table 6 – Nitrite Analysis Results

Statistical parameter	**Affluent**	**Effluent**								
Nitrite		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	1,45	0,97	0,91	0,98	0,74	0,74	0,69	0,44	0,51	0,44
Minimum	1,44	0,68	0,68	0,81	0,51	0,48	0,49	0,34	0,34	0,34
Maximum	1,46	1,26	1,29	1,15	0,91	0,91	0,89	0,61	0,61	0,54
Standard deviation	0,01	0,21	0,18	0,13	0,12	0,16	0,14	0,08	0,08	0,07
Efficiency Percentage		53,42%	53,42%	44,52%	60,27%	67,12%	66,43%	76,71%	76,71%	76,71%

Source: Authors, 2022

3.5 Nitrate

The results of the nitrate analysis showed significant efficiency in all systems. F1A, F2A, and F3A reached 48.80%, 49.89%, and 49.01% respectively. After passing through the first system, in F1B, F2B, and F3B, it reached 73.84%, 74.28%, and 74.50% respectively. Finally, in the systems with macrophytes FM1B, FM2B, and FM3B, there was a reduction of 83.07%, 82.41%, and 82.85% (Table 7).

Table 7 – Results of Nitrate analysis

Statistical parameter	**Affluent**				**Effluent**					
Nitrate		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	4,50	2,58	1,99	1,55	1,42	1,39	1,38	1,37	1,37	1,37
Minimum	4,47	2,28	0,18	0,18	0,18	0,18	0,18	0,18	0,18	0,18
Maximum	4,55	2,94	2,94	2,94	2,94	2,94	2,94	2,94	2,94	2,94
Standard deviation	0,02	0,18	1,08	1,03	1,00	1,00	1,00	1,00	1,00	1,00
Efficiency Percentage		48,80%	49,89%	49,01%	73,84%	74,28%	74,50%	83,07%	82,41%	82,85%

Source: Authors, 2022

3.6 Total Ammoniacal Nitrogen

The results of the analysis of Ammoniacal Nitrogen showed efficiency when passing through all systems. In F1A, F2A, and F3A, there was an efficiency of 53.30%, 53.23%, and 52.80% respectively as represented in Figure 14. Subsequently, as it went through the F1B, F2B, and F3B systems, the percentages rose to 78.49%, 78.06%, and 78.56%. In the CW with macrophyte, the result was 87.15% in all systems (Table 8).

Table 8 – Results of Total Ammoniacal Nitrogen Analysis

Statistical parameter	**Affluent**				**Effluent**					
Total Ammoniacal Nitrogen		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	25,63	12,77	12,95	13,21	6,19	6,10	6,01	3,49	3,54	3,66
Minimum	25,44	12,06	12,09	12,20	5,56	5,67	5,54	3,32	3,32	3,32
Maximum	25,85	13,73	13,88	14,00	6,49	6,35	6,38	3,86	3,85	3,89
Standard deviation	0,13	0,55	0,62	0,58	0,27	0,24	0,29	0,16	0,16	0,23
Efficiency Percentage		53,30%	53,23%	52,80%	78,49%	78,06%	78,56%	87,15%	87,15%	87,15%

Source: Authors, 2022

3.7 Total Phosphorus

The results of the Total Phosphorus analyzes showed good efficiency when passing through the F1A, F2A, and F3A systems with an efficiency of 29.64%, 29.85%, and 28.51% respectively. Moreover, there was an increase in total phosphorus reduction in the F1B, F2B, and F3B systems of 76.68%, 76.68%, and 76.61%. In systems with macrophyte the decrease in total phosphorus was 88.77% in both systems as shown in Table 9.

Table 9 – Results of Total Phosphorus analysis

Statistical parameter	**Affluent**	**Effluent**								
Total Phosphorus		F1A	F2A	F3A	F1B	F2B	F3B	FM1B	FM2B	FM3B
Average	51,45	37,03	37,49	37,92	12,41	12,37	12,40	5,95	6,00	6,06
Minimum	51,38	36,22	36,11	36,80	12,00	12,01	12,04	5,78	5,78	5,77
Maximum	51,48	37,56	38,66	38,93	12,74	12,79	12,93	6,18	6,22	6,23
Standard deviation	0,03	0,38	0,84	0,70	0,21	0,23	0,35	0,12	0,15	0,16
Efficiency Percentage		29,64%	29,85%	28,51%	76,68%	76,68%	76,61%	88,77%	88,77%	88,77%

Source: Authors, 2022

4 DISCUSSION

It is known that in vertical built wetland systems, the removal of solids occurs mainly due to the deposition and filtration of the influent material, especially in the first centimeters of the bed. These wetlands are efficient in the removal of suspended material, reaching values above 85% in systems with sand as a support medium (KADLEC AND WALLACE, 2009).

According to Pelissari *et al*. (2013), one of the most important factors for nitrification to occur, in addition to the adequate adaptation of the nitrifying microbiota, is the effective transfer of oxygen in the filter mass, due to intermittent feeding. Over the operating time, nitrification can be intensified, with the development of biofilm and improved removal of carbonaceous organic matter. With increased carbon removal, competition between heterotrophic and nitrifying bacteria decreases and allows for an improvement in nitrification. In reactors with biofilms, the establishment of nitrifying biomass depends on the application of lower organic loads (VON SPERLING, 2014).

CWs may not be efficient in removing P-PO43- due to intermittent feeding and the consequent oxygenation of the filter material, which causes desorption and subsequent release of phosphorus along with the treatment effluent (VYMAZAL, 2007). For Stefanakis and Tsihrintzis (2012), the low removals of P-PO43- from vertical flow CWs are related to the low contact time of wastewater with the filter material, and the efficiency in removing phosphorus in these systems is generally low since the beginning of operation. According to Fonseca (2001), the retention of phosphorus has helped in the prevention of leaching below the root zone, promoting the sustainability of crops that use irrigation with effluents from domestic sewage, due to the phosphorus from the sewage being retained in the soil.

The results of the experiment were satisfactory regarding the removal of Total Phosphorus, since the maximum removal was reached in the CW with macrophyte, reaching 88.77% efficiency. As for the CONAMA resolution 430 (2011), there is no minimum concentration of effluent discharge into water bodies. According to Sousa (2003), if phosphorus is released continuously without proper biological treatment, eutrophication may occur. Table 10 summarizes the highest efficiency achieved among the three CWs in series, demonstrating good reductions in the analyzed parameters.

Table 10 – Summary of the highest efficiencies achieved in the CW

Parameter	Filter without saturation	Filter with saturation	Filter with macrophytes
COD	58.40%	71.74%	71.73%
BOD	22.66%	29.09%	27.70%
Total suspended solids	89.87%	94.02%	93.63%
Nitrite	53.42%	67.12%	76.71%
Ammoniacal Nitrogen	52.30%	78.56%	87.15%
Nitrate	49.89%	74.50%	82.85%
Total Phosphorus	29.85%	76.68%	87.77%

Source: Authors, 2022

5 CONCLUSIONS

It is noticed that there is no standardization of the main operation and design parameters, or the predominance in the forms of flow used, when it comes to CWs. This is mainly because these are experimental studies and, therefore, it is essential to adopt different criteria for the expansion of knowledge

There is a greater growth of studies related to CWs in Brazil, and this extends to the Center-West region. Even if on a smaller scale, there is a greater amount of research mainly within universities. In Mato Grosso, there are still few studies; these being implemented, and only in the state capital, Cuiabá City. Thus, there is a great potential to be studied with future feasibility of social and economic proposals for the state.

In this sense, the present research addressed the treatment of synthetic sewage through 3 CW systems, two of them with macrophyte and the other without for comparison of results. It was found that there was an improvement in the parameters of Suspended Solids, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD), Ammoniacal Nitrogen, Total Phosphorus, Nitrate, and Nitrite. The parameter with the least significant reduction in the system was BOD, with no significant differences between systems without and with macrophytes.

Therefore, it was found that the maximum reductions in the parameters were: COD (71.74%), BOD (29.09%), Ammoniacal Nitrogen (87.15%), Total Phosphorus (88.77%), Nitrate (82 .85%), Nitrite (76.71%), and Total Suspended Solids (94.02%). Based on these results, it is suggested the future studies address the replication of this system on a larger scale for the treatment or polishing of effluents from sewage treatment plants or similar, also changing the type of macrophyte in the system for possible comparisons with this study.

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How to quote this article

KURIKI, M. S.; SANTOS, F. L.; POLETO, C. Small-Scale Wetland Model for Synthetic Sewage Treatment. **Ciência e Natura**, Santa Maria, v. 44, Ed. Esp. VI SSS, e25, 2022. DOI: 10.5902/2179460X68834.