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DOMESTIC SEWAGE TREATED AS A SOURCE OF WATER AND NUTRIENTS FOR SUSPENDED CULTIVATION OF ANTHORIUM

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1 RESUMO

A oferta de água para atividades urbanas e industriais tem sido sobrecarregada pelo aumento populacional e aumento de produção, sendo imprescindível seu descarte adequado e tratamento correto para seu possível reúso em outras atividades. Este estudo teve como objetivo avaliar o potencial de produção de antúrio (Anthurium andraeanum) em um sistema de cultivo suspenso fertirrigado, utilizando esgoto doméstico tratado como fonte de água e nutrientes. Foram comparados três tratamentos: água potável com fertilizantes (TA), água de reúso com fertilizantes complementares (TRA) e apenas água de reúso (TR). Os resultados mostraram que o tratamento TRA, não apresentou diferença estatisticamente significativa em relação ao tratamento TA em relação a aspectos quantitativos e qualitativos do crescimento do antúrio (comprimento da haste, espádice, espata, folha maior e número de flores) e produtividade. Apesar da presença de Escherichia coli na água de reúso, o cultivo foi considerado seguro por não apresentar contaminação no tecido vegetal, além disso, o antúrio não é destinado à alimentação humana. Conclui-se que a água de reúso, enriquecida com fertilizantes como suplemento nutricional, demonstrou viabilidade para ser empregada no sistema de cultivo suspenso de antúrio. Essa abordagem permite uma economia significativa tanto no consumo de água quanto de fertilizantes.

Palavras-chave: água de reúso, flores, sustentabilidade.

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2 ABSTRACT

The supply of water for urban and industrial activities has been overloaded by population growth and increased production, necessitating adequate disposal and correct treatment for possible reuse in other activities. This study aimed to evaluate the production potential of

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anthurium (*Anthurium andraeanum*) in a fertigated suspended cultivation system using treated domestic sewage as a source of water and nutrients. Three treatments were compared: drinking water with fertilizers (TA), reused water with complementary fertilizers (TRA) and reused water only (TR). The results showed that the TRA treatment did not significantly differ from the TA treatment in terms of quantitative or qualitative aspects of anthurium growth (length of the stem, spadix, spathe, largest leaf and number of flowers) or productivity. Despite the presence of *Escherichia coli* in the reused water, the cultivation was considered safe because it did not cause contamination in the plant tissue. Furthermore, anthurium is not intended for human consumption. It was concluded that reused water enriched with fertilizers as a nutritional supplement was useful for use in the anthurium suspension cultivation system. This approach allows for significant savings in both water and fertilizer consumption.

Keywords: reuse water, flowers, sustainability.

3 INTRODUCTION

The exponential increase in population and the consequent need to increase agricultural and industrial production result in a great demand for natural resources. Water has long been considered by humanity to be an inexhaustible resource and, perhaps for this reason, poorly managed (Florencio; Bastos; Aisse, 2006).

Industrial and urban human activities generate waste with high toxicity potential that is responsible for the contamination of water bodies and is a source of inoculum for the spread of diseases that affect human beings; this waste is directly linked to the lack of sewage treatment or poor quality of wastewater. even when present (Tundisi, 2014). However, according to Santos and Vieira (2020), of the total value of treated sewage, only 1.5% is intended for reuse.

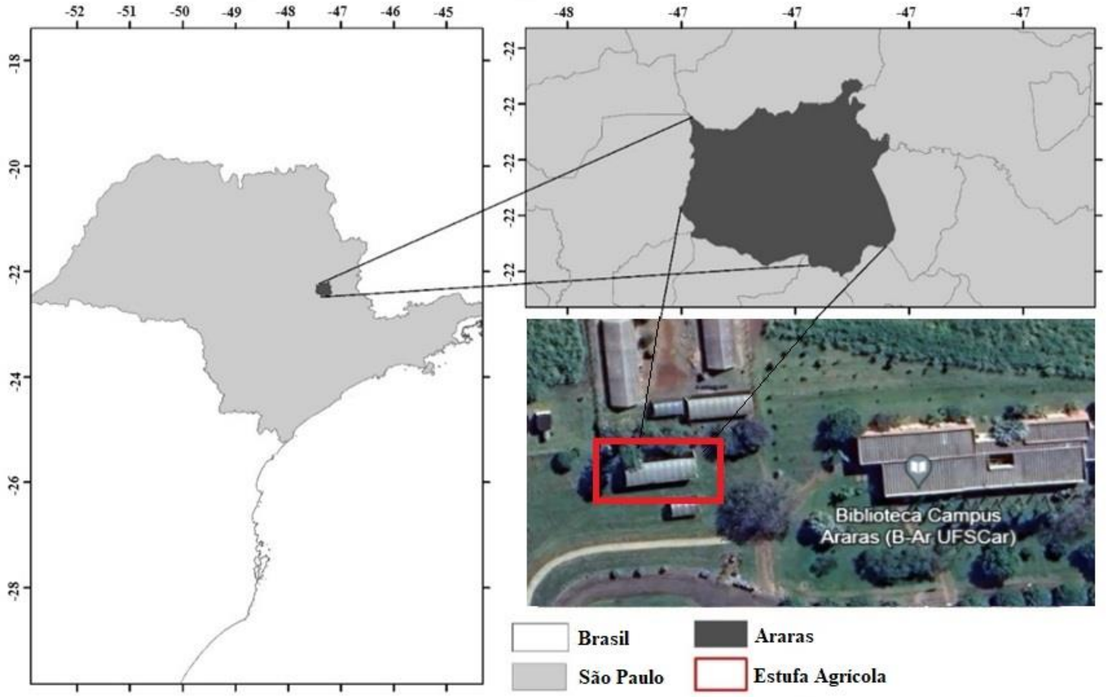
One way to mitigate the environmental impacts resulting from the inadequate disposal of contaminated water is to promote its conservation and seek alternatives that allow it to be reused for various purposes. A measure already widespread in other countries is the use of wastewater for agricultural irrigation purposes (Urbano *et al.*, 2017).

The present work aimed to evaluate the production potential of anthurium in suspension cultivation using treated domestic sewage as a source of water and nutrients.

4 MATERIALS AND METHODS

The suspended cultivation of anthurium was carried out at the facilities of the Department of Natural Resources and Environmental Protection (DRNPA) installed at the Center for Agricultural Sciences (CCA) of the Federal University of São Carlos (UFSCar), located in the municipality of Araras, SP, at a latitude equal to 22°18 '53.23" South and longitude equal to 47°23'00.91" West (Figure 1).

Figure 1. Location and characteristics of the study area

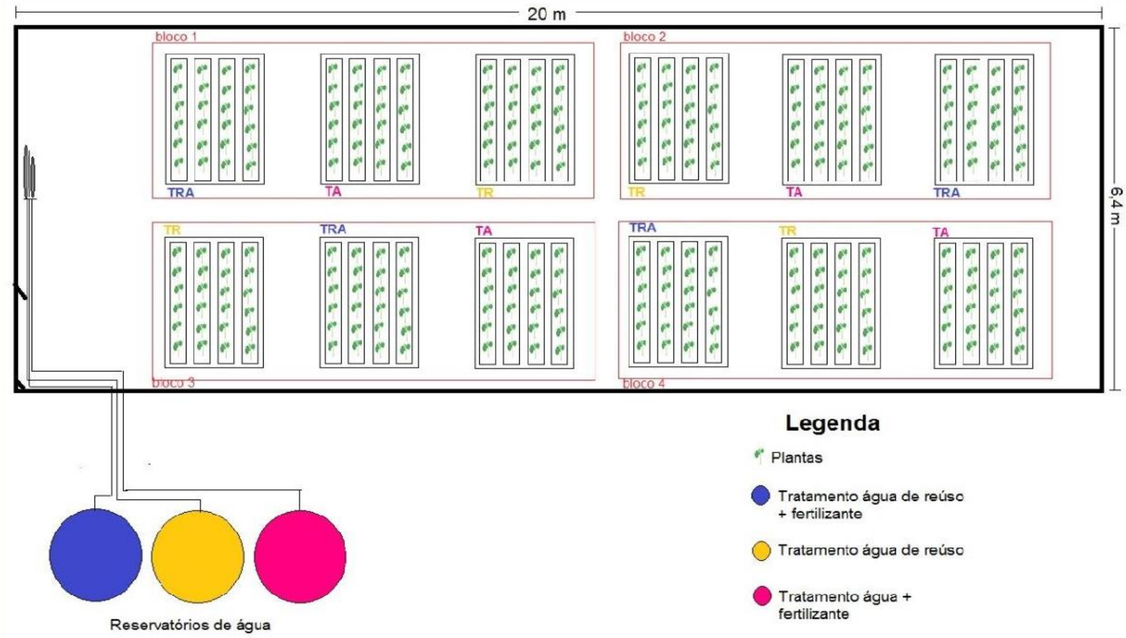


Source: The author

The agricultural greenhouse was built with a metal structure with an arched roof, covered with transparent polyethylene, and 6.4 metermetres wide, 20.0 metermetres long and 5.0 metermetres high. To close the sides, a shade cloth was used. The cultivation system adopted was a suspended system with fertigation, also known as soilless cultivation with coconut fiber and drip irrigation.

The experiment consisted of twelve cultivation benches, each measuring 2.0 metermetres long and 1.8 metermetres wide; the benches were divided into 4 randomized blocks, each containing one of the three treatments, where TA was treated with drinking water supplemented with chemical fertilizers, in accordance with the fertilization recommendations for anthurium cultivation, according to Leme (2009); TRA was treated with reused water supplemented with chemical fertilizers, in which case the nutritional supplement was applied after chemical analysis of the reused water, disregarding the nutrients already present; and TR was treated with reused water without the addition of fertilizers (Figure 2).

Figure 1. Schematic of suspended cultivation benches.



Source: Author

Each bench consisted of 32 plants, with 128 plants allocated to each treatment, for a total of 384 plants in the three treatments. The plants were fertigated using a drip irrigation system, and irrigation was carried out using soil sensors.

The reuse water was collected at the Pilot Sewage Treatment Station of CCA – UFSCar, and the characterization of the treated sewage showed the following results: pH 7.2, turbidity 1.14 (NTU), electrical conductivity (EC) 61.1 µS cm $^{-1}$, sodium (Na) 48.70 mg L $^{-1}$, potassium (K) 13.26 mg L $^{-1}$, calcium (Ca) 147.33 mg L $^{-1}$, total nitrogen (NT) 32.86 mg L $^{-1}$, total phosphorus (PT) 2.3 mg L $^{-1}$, magnesium (Mg) 15.67 mg L $^{-1}$, total organic carbon (TOC) 11.90 mg L $^{-1}$, *and total organic carbon (TOC)* 2.1x10 ^{3} NMP 100 ml $^{-1}$ (Oliveira; Bastos; Souza, 2019).

The anthurium cultivar chosen was Antúrio Sumi, a variety widely used in Brazil, mainly in the southeastern region. Ornamental plants are ideal for protected environments such as balconies or winter gardens. This plant is widely used in decorations and floral arrangements as a cut flower. The seedlings were purchased from a certified producer (Van Vliet Antúrios) aged 5 months, and all the culture treatments were carried out.

To conduct the comparative analysis of treatments, multiple characteristics were considered, covering physical dimensions, such as plant height, number of leaves per plant, plant stem length, shape and size of the spathe, and the number of flowers per plant. . Finally, microbiological aspects were evaluated using 3 M Petrifilm plates, with the purpose of identifying and quantifying the presence of total coliforms *and E. coli* in flowers. For the analyses, 10 plants were randomly selected from each treatment, excluding plants located on the edges.

The results were statistically analyzed using R Core Team software, where the data obtained were subjected to analysis of variance (ANOVA) to verify which treatments significantly affected biomass production and the quality and quantity of the flowers. The Shapiro–Wilk test was subsequently used to analyze the normality of the data.

5 RESULTS AND DISCUSSION

According to the statistical analysis of the biometric parameters determined by the 5% Tukey test, we observed that the analyzed parameters did not significantly differ between the TRA and TA groups. However, the TR treatment had inferior results, indicating that its low electrical conductivity is related to the decreased fertility of the solution. According to Taiz *et al.* (2021), nutritional deficiencies can cause physiological and morphological disorders in plants.

According to Leme and Honório (2004), following the Dutch classification, the TRA and TR treatments, which presented averages of 33.72 and 32.27 centimeters, respectively, for the length of the stem, are classified as 7.5; that is, in this classification, Anthurium stems can range from 301 mm to 350 mm in length. The plants in the TR treatment had a shorter stem length than did those in the TRA and TA treatments, at 26.40 cm, which was classified as size 6, where the length of the anthurium stem ranged from 251 mm to 300 mm. (Table 1).

Table 1. Biometric analyses of anthurium cultured in protected cultivation media.

Treatment	CH (cm)	CFM (cm)	CEPD (cm)	CES (cm)	AP (cm)	NFP	NFL
TRA	33,72 a	26,10 a	5,86 a	11,23 a	41,71 a	14,34 a	2,80 a
TA	32,27 a	25,82 a	5,82 a	10,98 a	39,79 a	14,75 a	2,77 a
TR	26,40 b	18,05 b	4,90 b	8,24 b	32,43 b	12,08 a	2,04 b
				ANOVA			
p-valor	$1,43x10^{-3}$	$6x10^{-6}$	$5,4x10^{-6}$	$1x10^{-6}$	$4,6x10^{-4}$	0,055	0,002
C.V. (%)	5,18	3,09	1,51	1,83	4,3	9,5	7,69
				Shapiro–Wilk			
P-valor	0,489	0,337	0,582	0,658	0,163	0,087	0,946

Means followed by the same letter in the column do not differ significantly from each other according to the Tukey test at 5% probability. TRA = treated domestic effluent + mineral fertilizers; TA = drinking water + mineral fertilizers; TR = treated domestic effluent only. CH = plant stem length (cm); CFM = length of the longest leaf (cm); CEPD = spadix length (cm); CES = spathe length (cm); AP = plant height (cm); NFP = number of leaves per plant; NFL = number of flowers per plant.
Source: Author

When analyzing the productivity results using the Tukey test with a significance level of 5%, it was found that the TRA treatment presented an average productivity of 52.5 flowers per bench, containing 32 plants, which did not differ significantly from the TA treatment. An average of 52.4 flowers were recorded per bench. On the other hand, the TR treatment had a significantly greater difference than the TRA and TA treatments, with an average productivity of 33.3 flowers per bench, indicating lower performance. The coefficient of variation between treatments was ± 3.46%, and the Shapiro–Wilk test with a p value of 0.633 indicated that the residues were considered normal. (Table 2)

The low productivity observed in the TR treatment can be attributed to plant nutrition. A lack of nitrogen (N) was identified as the factor responsible for the reduction in the number of flowers produced on pepper crops (Silva, 2013). Furthermore, iron (Fe) and manganese (Mn) deficiency characterize the production of flowers with low market quality, which results in smaller flowers and shorter shelf life (Pinho *et al.*, 2012).

Table 2. Average monthly productivity per treatment in a suspended system with fertigation in protected anthurium cultivation.

Treatments	Productivity (flowers)
TRA	52.5 to
TA	52.4 a
TR	33.3b
ANOVA	
p value	0
CV (%)	3.46
Shapiro- Wilk	
p value	0.633

Source: Author

The results of this study revealed that the use of treated domestic sewage was effective at preserving the physical and microbiological integrity of cultivated plants. However, when domestic sewage is used as the only source of nutrients, plant productivity tends to significantly decrease.

The research results indicate that although treated domestic sewage contributes to maintaining the physical and microbiological quality of plants, its isolated use is not sufficient to optimize productivity. Therefore, supplementation with additional fertilizers may be necessary to maximize crop production.

The use of treated domestic sewage with nutritional addition enabled the maintenance of high productivity, and the results indicate the feasibility of applying treated domestic sewage as an alternative and sustainable source of water and fertilizers in the protected cultivation of anthurium in coconut fiber substrates, ensuring the phytosanitary integrity of the plant and the safety of the final product.

The use of treated domestic sewage supplemented with mineral fertilizers (TAs) produced satisfactory results in relation to the productivity and agronomic characteristics desired by the market for the cultivation of anthurium, which is a sustainable source of water and nutrients. The productive and agronomic potential of TRA was the same as that of TA for the cultivation of anthurium, as evidenced by the savings in drinking water and mineral fertilizers; however, the TR treatment involving the use of only treated domestic sewage as a source of water and nutrients presented severe nutritional deficiencies when compared to TRA and TA, which are nutrient supplements.

5 CONCLUSIONS

The reuse of water enriched with fertilizers as a nutritional supplement demonstrated the feasibility of its use in anthurium suspended cultivation systems. This approach allows for significant savings in both water and fertilizer consumption.

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