

## **Biogas Production Using the *Eichornia Crassipes* (Mart.) Solms, 1883 (Magnoliophyta: Pontederiaceae) From the São Francisco River, In Paulo Afonso-Ba**

Luiz Antônio Pimentel Cavalcanti<sup>1</sup>, Hudson Bonifácio dos Santos<sup>2</sup>,  
Natielli Ferreira Rodrigues<sup>3</sup>

<sup>1</sup> Federal Institute of Education, Science and Technology of Bahia - IFBA, Paulo Afonso Campus, Bahia.

<sup>2</sup> Federal Institute of Education, Science and Technology of Bahia - IFBA, Paulo Afonso Campus, Bahia.

<sup>3</sup> Federal Institute of Education, Science and Technology of Bahia - IFBA, Paulo Afonso Campus, Bahia.

Corresponding Author: luizufpe@yahoo.com.br

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**Abstract:** Together with the growth of environmental impacts, the need to produce renewable energy as a form of mitigation has been portrayed as one of the most important and discussed issues in the world. The baronesa phenomenon in the São Francisco River, occurred in the Paulo Afonso-BA microregion, shocked the native population as well as surrounding cities, by the level of consequences resulting from this event. Baronesa (*Eichornia Crassipes*) found in the region brought with it ecological and financial damages. The present work aims to evaluate the viability of biogas production from this species, based on a case study carried out through samples collected after the phenomenon. An artisanal biodigester was used to fill its interior with the biomass produced from the mixture of baronesa mashed with bovine manure, then it was hermetically isolated for 55 days. Afterwards, the success of the procedure performed through the results obtained with the flame test, showing long-term efficiency, is confirmed. Once confirmed the feasibility of a sustainable alternative to the baronesa phenomenon occurred in the São Francisco River, basically consisting of the production of clean energy.

**Keywords:** Energy, Biodigester, Sustainability.

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Date of Submission: 29-01-2019

Date of acceptance: 14-02-2019

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### **I. Introduction**

Nowadays, energy and environment issues are widely discussed in national and international forums. In other words, these debates portray the importance of producing clean energy that contributes to preserving the environment by boosting social and economic development on a national and global scale.

One of the first sources of energy used by humans was biomass. Currently, this modality of energy generation is emerging as an alternative for the replacement of fossil fuels in the processes of thermal conversion. The energy generated from biomass consists of the derivation of living matter, being used as fuel in three aspects: solid, liquid and as biogas from anaerobic decomposition or gasification (REIS, 2011).

The specie found, *Eichornia crassipes* (Mart.) Solms, 1883 (Magnoliophyta: Pontederiaceae), commonly known as baronesa, has 95% water in its structure. Possessing long roots (measuring up to one meter), petioles, rhizomes, leaves, stolons and inflorescences. The submerged region of the plant reaches a height ranging from a few centimeters up to a 1 meter.

For Moraes and Cruz (2015), the baronesa causes problems in reservoirs of hydroelectric plants due to their rapid proliferation. On the other hand, one of the advantages of this species is the ability to be a natural filter of organic residues, presenting the capacity to incorporate in its tissues a great quantity of nutrients, its long and thin roots, has enormous amount of bacteria and fungi, act on the molecules, breaking its structure and allowing the plant to assimilate these toxic components.

The emergence of aquatic plants, popularly known as baronessas, in the Paulo Afonso Microregion in the state of Bahia has shown the chaos caused by the lack of commitment of the public authorities, as well as of the riverine populations, regarding the São Francisco River. The presence of such plants is a consequence of the inadequate disposal of organic materials at the banks, and also, even more severely, the quantity of untreated sewage dumped into the river, which no longer presents flood periods, further problematizing the situation.

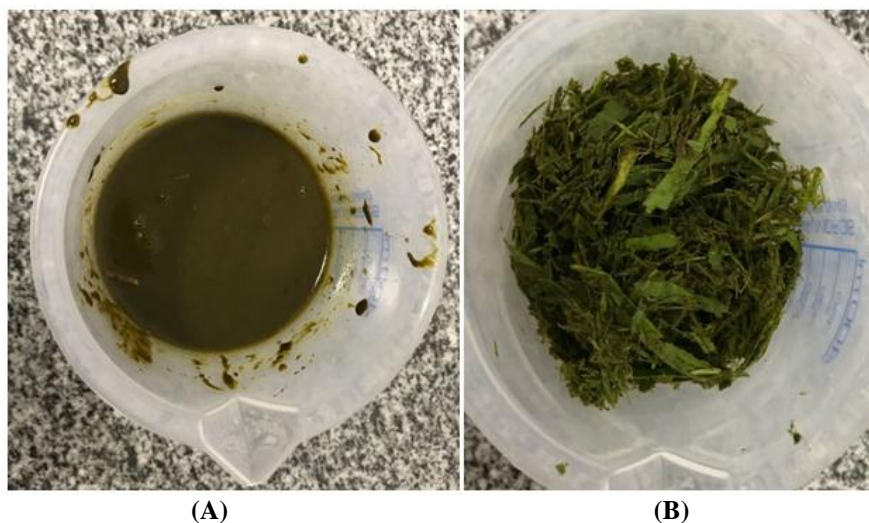
The present work aims to evaluate the viability of the biogas production from the *Eichornia Crassipes* species of frequent occurrence due to anthropic actions in the São Francisco River.

## II. General Objective

To evaluate the viability of biogas production from the *EichorniaCrassipes* collected in the São Francisco River in the Prainha in the city of Paulo Afonso-BA.

## III. Methodology

The biogas production process from *EichorniaCrassipes* was initiated with the collection of fresh bovine manure and some plant units in the Prainha on the São Francisco River. After the collection, the plants went through the process of cutting and sanitizing to remove impurities present in the leaves and the stem. Cleaning was given by washing by turbulent flow of water followed by distilled water, Figure 1 shows the samples used in the process.



**Figure 1.** Sample of fresh bovine manure (A), shredded leaves and stem used in biogas production(B).  
**Source:**Personal Collection, 2018.

Continuing the process, after being selected, the baronesa samples were ground for 5 min. in the blender, then the crushed sample had its mass measured with the aid of a semi-analytical balance and an approximate mass of 78 g was verified, later it was measured to the mass of bovine manure in the balance verifying a mass of approximately 222 g of manure.

Subsequently, the materials were homogenized for 5 min. in the blender in order to increase the contact surface between the components contributing to the better efficiency in the biogas production, then the mixture was deposited in the becker (Figure 2).



**Figure 2.** Mixture obtained from mashed Baronesa and bovine manure.  
**Source:**Personal Collection, 2018.

A mixture of pasty texture was obtained that was deposited in the batch-type biodigester handcrafted in PVC material with a maximum capacity of approximately 981,25 cm<sup>3</sup> of organic matter, in this type of biodigester the organic material is introduced at once(Figure 3).



**Figure 3.** Pasty mixture inserted in the biodigester.  
**Source:**Personal Collection, 2018.

To carry out the fermentation and to generate the biogas, the biodigester was isolated, filling the outermost radius with water and then capping it with a holder having a check valve. The biodigester was kept hermetically sealed and allowed to stand at a temperature of approximately 32 °C for 55 days, being verified over time that in fact there was gas production, Figure 4 presents the biodigester.



**Figure 4.**PVC biodigester used in the biogas production process.  
**Source:**Personal Collection, 2018.

As a way of analyzing and representing the efficiency of the experiment, the calculation of the total volume of gas obtained over the days was performed. The mathematical expression used as presented in Equation 1:

$$V_c = \pi \times r^2 \times h \quad (1)$$

At where:

$V_c$  : Cylinder volume;

$r$  : Cylinder radius;

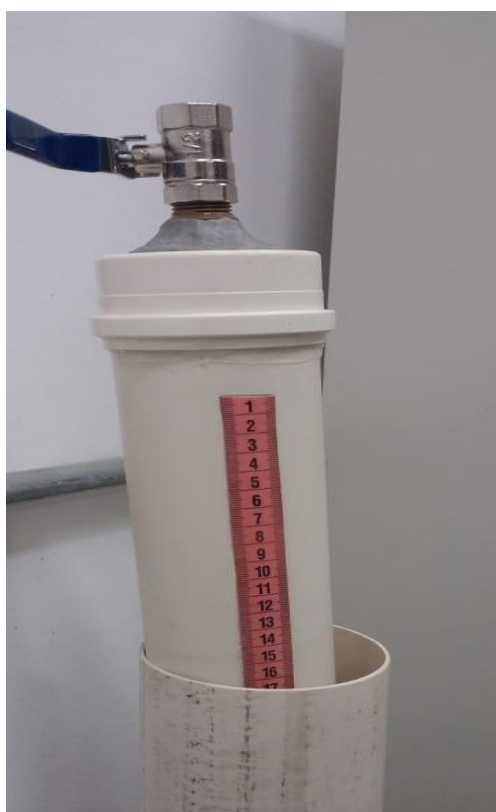
$h$  : Cylinder height.

#### IV. Results And Discussion

The most affected region of the city of Paulo Afonso known as Prainha, by far is considered the most impaired, under the financial and ecological aspect, that aquatic specie evidenced. As a tourist point of Paulo Afonso, the Prainha has easy access, being a considerably safe river and more frequent destination of both the Paulo afonsina and tourist population. Besides the natural leisure, the locality still counts on the presence of riverside restaurants to attend the visiting population, aiming the comfort of the same one. With the presence of the baronesa, access to the river became restricted, revealing the diversity of problems ignored by public management together with the native population.

However, the species present in the river presents biological properties that under specific conditions are excellent producers of biogas, making it useful in the production of renewable energy (MELLO et al., 2015). Biogas is the product that results from fermentation, in the absence of air, using animal waste, vegetable and organic residues, under adequate humidity conditions (SOETHE, 2014). The reaction is called anaerobic digestion and biogas is composed basically of 55%-65% de  $CH_4$ ; 34%-45% de  $CO_2$ ; 0%-1% de  $N_2$ ; 0%-1% de  $O_2$ ; 0%-1% de  $H_2S$  (BORGES NETO e CARVALHO, 2012).

Soon after the experiment was carried out, the evolution of the gas production from the obtained mixture was checked periodically. Initially, the progress of biogas generation presented low gasification rates. However, over time, evolutions were noticed, revealing the efficiency of the biomass used as source. Figure 5 shows the gasification index in the first three weeks.



**Figure 5.** Gasification index in 3 weeks.  
**Source:** Personal Collection, 2018.

A displacement of the 17 cm biodigester column was verified, evidencing the biogas production. Afterwards, the flame test was carried out, which consists of the burning of the biogas produced through the release by the valve present in the biodigester. If the flame obtained remains in its natural color, the result of the production will be carbon dioxide (CO<sub>2</sub>). However, if the flame color change to blue, the biogas obtained produce methane, which resulted in the test being carried out. Figure 6 shows the result obtained for the flame test.

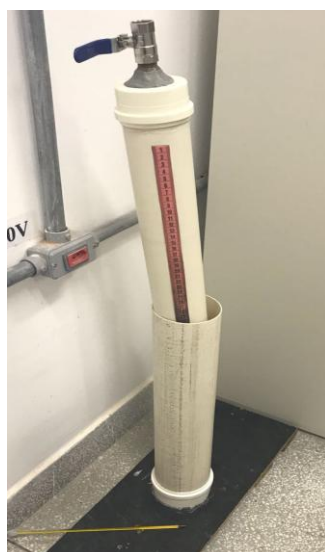


**Figure 6.** Flame test in the biodigester.  
**Source:**Personal Collection, 2018.

As expected, the blue flame was obtained, proving the existence of methane gas as a product of the digestion of the biomass deposited in the biodigester. The test was performed in the dark aiming the safety and verification of the quality of the flame obtained.

After the release of all the gas present, the biodigester was again isolated for the observation of new advances. After 26 days of the first test, the artisanal biodigester reached the maximum limit with biogas production from the already deposited biomass, presenting a displacement of the column of the biodigester of 30 cm.

This result reinforces the idea that the baronesa, together with cattle manure, is an excellent producer of biogas, with better results in the long term, and verified the difference of 5 days from the first registration (21 days in the first and 26 days in the second), practically doubled production. Figure 7 illustrates the recording of the second stage of the experiment.



**Figure 7.**Record of the biodigester after 26 days of the first test.  
**Source:**Personal Collection, 2018.

The factor that has the greatest influence on the fermentation process of the biodigester consists of the temperature, this influence on the volume of biogas production and biofertilizer (SOETHE, 2014). The methanogenic bacteria present a temperature characteristic for maximum biogas production (MELLO et al., 2015). The same authors point out, as an ideal, the constant value of 35 °C, noting that variations of only 3,0 °C are sufficient to decrease the biogas production. At temperatures below 10 °C, production ceases completely (BORGES NETO and CARVALHO, 2012).

Through the calculation of volume for the gas production during the period evaluated in the experiment, which demonstrated a production of approximately 1,119.19 cm<sup>3</sup> for the two observations, it was possible to prove the effectiveness of the achieved efficiency, evidencing the utility of the baronessas together cattle manure as a form of mitigation for the region's problem.

Even remaining still under analysis, the results obtained throughout the experiment were compatible with the expected, providing an alternative for energy generation. In addition, it demonstrates the importance of seeking solutions to environmental problems, where such solutions will bring benefits to society.

## V. Conclusion

The tests proved the viability of biogas production from the anaerobic digestion of baronesa, despite the long period for the formation of methane, which demonstrated a production of approximately 1,119.19 cm<sup>3</sup> for the experiments carried out, it was possible to verify the effectiveness of the efficiency achieved, evidencing the baronesa usefulness together with the cattle manure as an alternative of mitigation for the problem of the region.

Therefore, it was verified the viability of a sustainable alternative for the Baronesses present in the São Francisco River in Paulo Afonso-BA, giving useful to this phenomenon consisting in the production of clean energy, which is one of the focuses of the current scenario of development.

This alternative presents an economically feasible solution to the current problem of the region, together with measures developed to address the main problem, based on the orientation of the population by public authorities for environmental preservation and ecological awareness.

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Luiz Antônio Pimentel Cavalcanti. " BiogasProductionUsing The EichorniaCrassipes (Mart.)Solms, 1883 (Magnoliophyta: Pontederiaceae) From The São Francisco River, In Paulo Afonso-Ba." IOSR Journalof Environmental Science, ToxicologyandFood Technology (IOSR-JESTFT) 13.2(2019): 65-70.