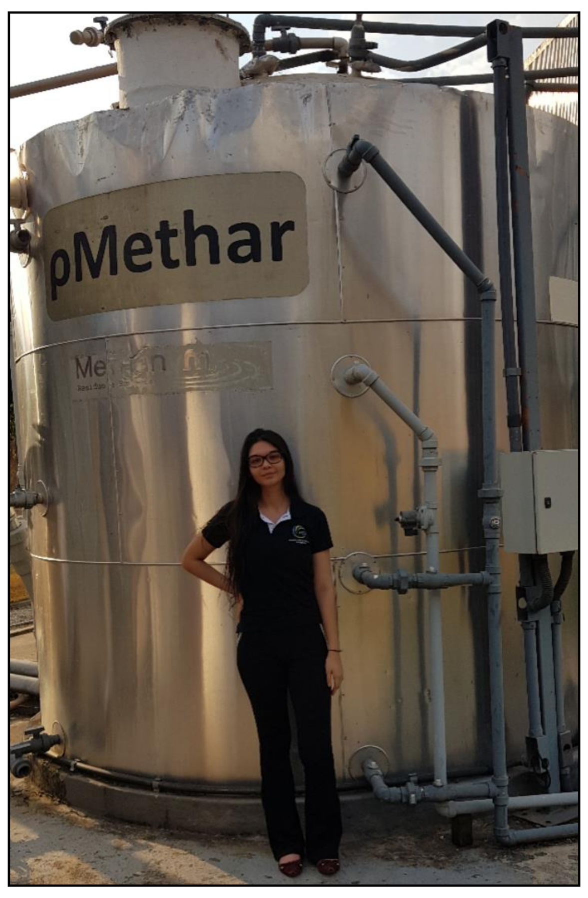
Potential for energy use of food waste generated at the university restaurant of UNICAMP



S.H. Daniel*, L.M.G. Souza*, B.S. Moraes**

***Department of Energy, UNICAMP, São Paulo, 13083-860, Brazil**
****Interdisciplinary Center of Energy Planning, UNICAMP, São Paulo, 13083-896, Brazil**

Introduction

Currently, the main restaurant at the State University of Campinas (UNICAMP) annually discharges, on average, 99 tons of food wastes, which are sent to the landfill as the final disposal method. However, the biogas generated at this location has only been incinerated in flares, thereby wasting enormous potential for energy production. Besides, the distance between the university and the landfill has resulted in high transportation costs and the uncontrolled decomposition of organic material has caused several environmental problems. Thus, anaerobic reactors stand out as an alternative to landfills, as they can be built in a decentralized manner on the property itself, in addition to being designed to treat waste in a controlled way and optimize the production of biogas, rich in methane (CH_4), for self-generation to energy. In this context, aiming at verifying the feasibility of implementing this system in the institution's facilities, the food wastes from the UNICAMP university restaurant (UR) were subjected to biochemical methane potential (BMP) tests, following the procedures described in VDI standard 4630, to determine their energy production potential. Gas data were adjusted using modified Gompertz mathematical model to obtain the kinetic parameters of the process, with the purpose of assisting in scaling and calculating the system's energy production potential for a large size plant. The possible applications of biogas within the university were analyzed, as well as their respective economic viability.

Results & Discussion

With the BMP (Figure 1) at the determined hydraulic retention time (297.2NmLCH_4 gSV^{-1}) and the temporal analysis of the volatile solids content found in the food waste (Figure 2), it was possible to estimate the range of annual CH_4 production that could be generated at UNICAMP (5582Nm³CH_4 to 7707Nm³CH_4).

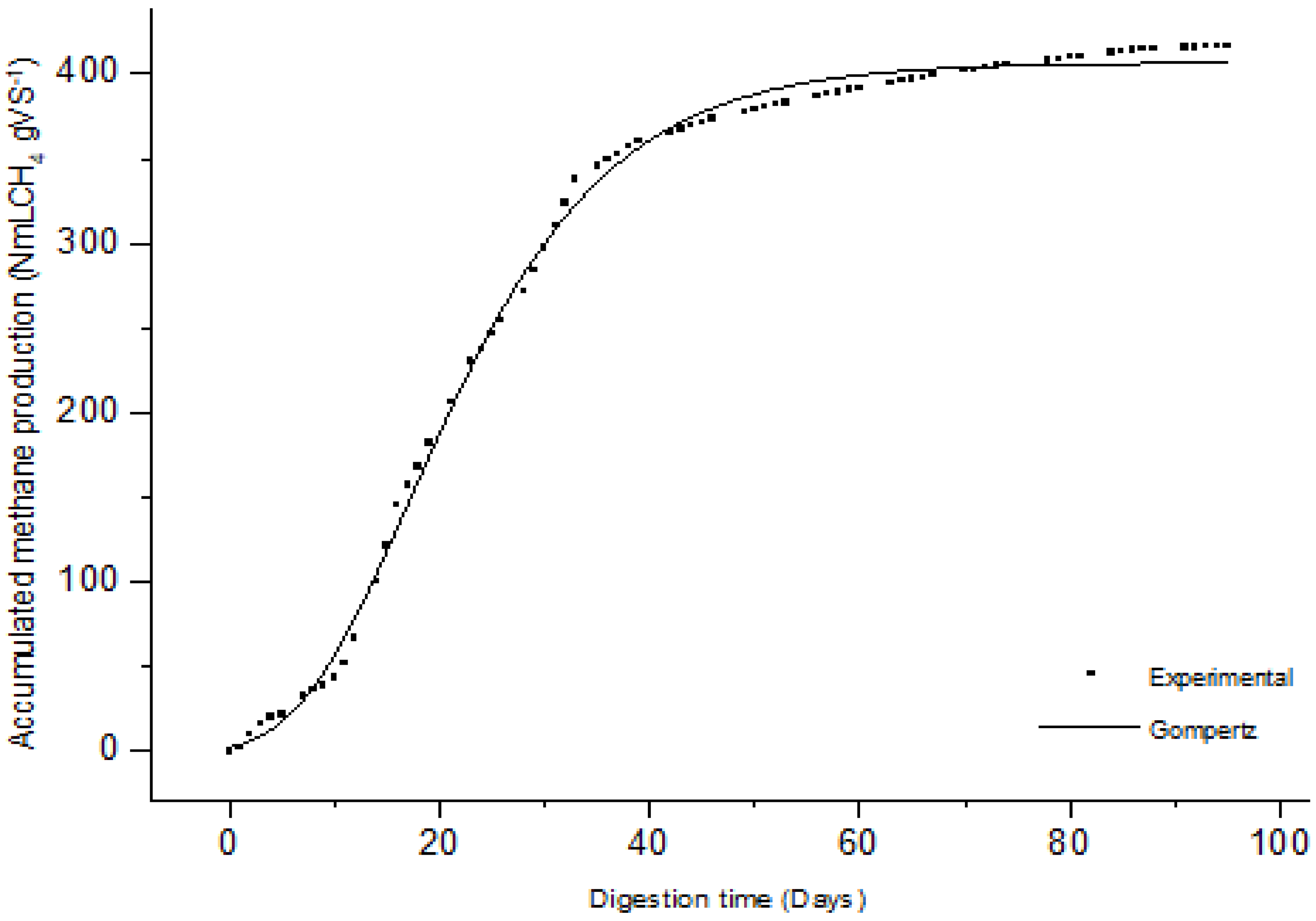


Figure 1. BMP of food waste and modified Gompertz curve adjustment to the experimental data

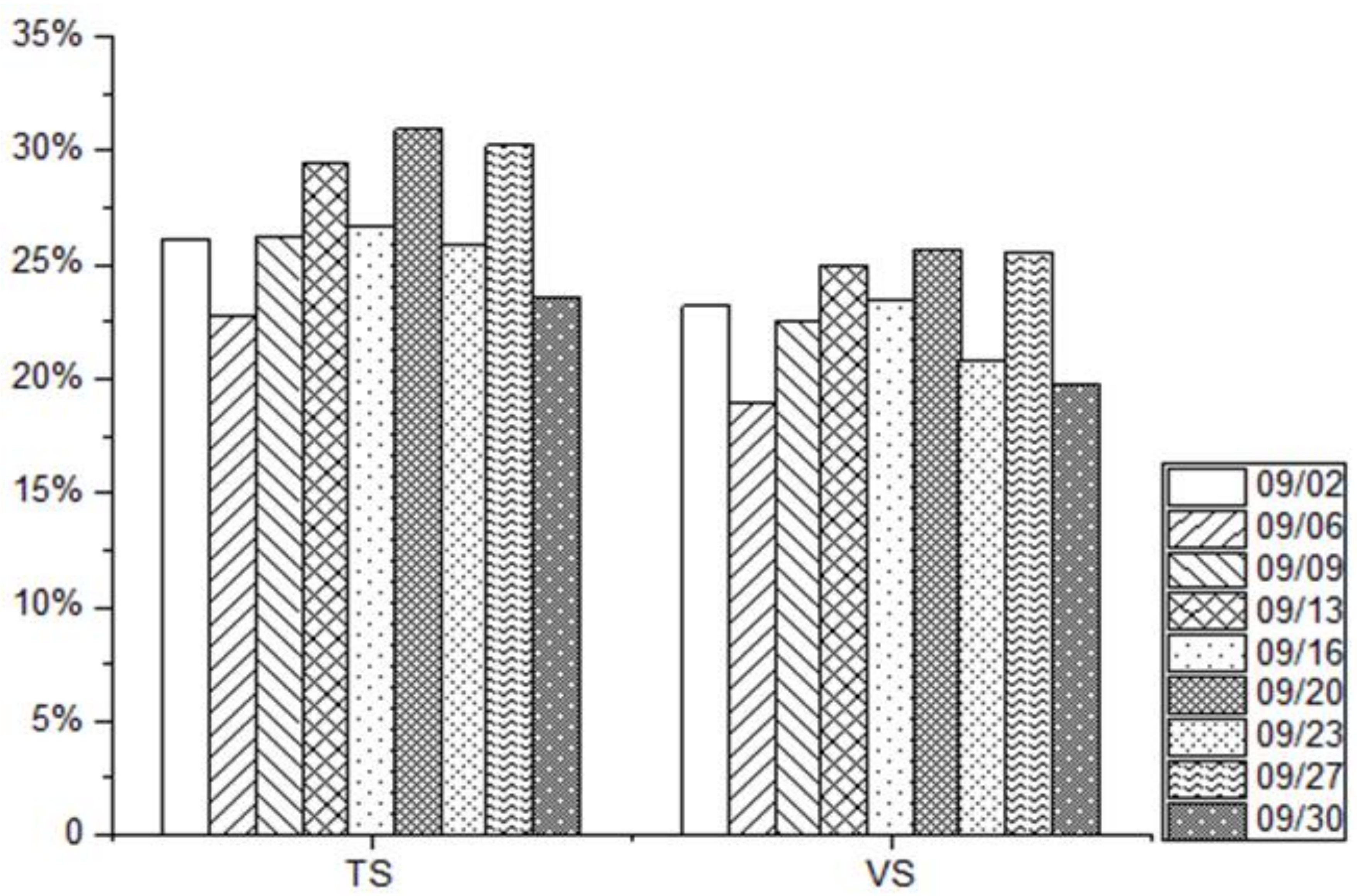


Figure 2. Variation in the solids content of food waste over time

With that, the minimum and maximum scenarios of replaced quantities and savings generated for each suggested application of CH_4 within the University were determined, as can be seen in Table 1 and Table 2. Also checking the temporal analysis of the solids content, it was possible to find the highest total solids content found in this waste (31%), concluding that for the results mentioned to be achieved, the university would have to build a wet anaerobic reactor with 23.6 m³ of gross volume and 3m in height and diameter (Figure 3).

Table 1. Quantity range of products to be replaced by CH_4

Application	Minimum	Maximum
Electricity	14 MWh	19 MWh
Vehicular and boiler fuel	5473 L diesel	7556 L diesel
Cooking gas	4307 kg LPG	5946 kg LPG

Table 2. Annual savings generated by CH_4 replacement (US$)

Application	Minimum	Maximum
Electricity	870.27	1201.43
Vehicular and boiler fuel	3102.08	4282.69
Cooking gas	3982.24	5497.89
Waste disposal	8163.98	

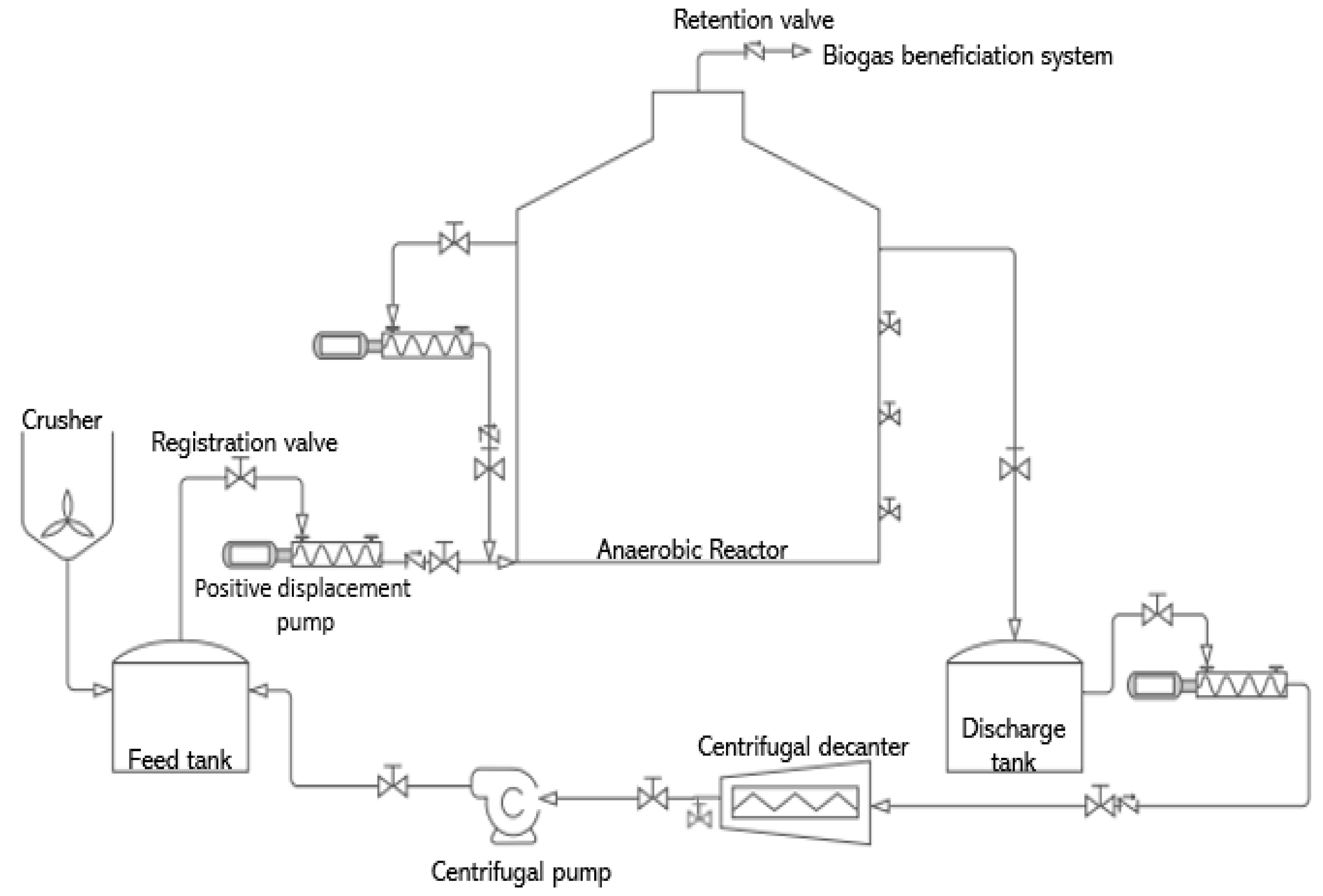


Figure 3. Scheme of the AD system for UR food waste

The estimated investment for the construction of the anaerobic digestion (AD) plant resulted in US$34839.30. Thus, the suggested applications can be carried out with the following investments: electricity (US$69136.45), vehicular fuel (US$120741.89), boiler fuel (US$65921.08) and cooking gas (US$77938.80), with paybacks, in years: electricity (7.9-9.3), vehicular fuel (11.3-15.3), boiler fuel (5.4-6.6) and cooking gas (5.8-7.3).

Conclusions

With the construction of the AD system, the university would avoid the final disposal and transport of its waste to landfills. It could also supply internal demands with the energy generated by the process, which would help to reduce the use of fossil fuels and overcrowding of landfills. Besides, the system would favor environmental conservation and the diversification and security of the energy matrix. In addition, the project has the potential to become a technology for training, research and academic teaching in the area of waste treatment and bioenergy. Thus, it can contribute to sustainable development and the concept of the university as a living laboratory, carrying out the environmentally appropriate treatment of organic wastes and generating clean energy on campus.

sayurihigo.engenharia@gmail.com