

Study of the Methanogenic Potential of the Organic Fraction of Household Waste and Similar with and Without Inoculum (Leachate): Case of the AKÉPÉ Technical Landfill Center (TOGO)

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Abstract In this work, a series of experiments were carried out on the methanogenic potential of the organic fraction of Household Waste and Similar consisting of food waste, green waste, paper-cardboard, wood and fines, to which treated leachate (L) from the Aképé Technical Landfill Center was added as inoculum. Composite samples HWS1 (rainy season) and HWS2 (dry season) from the year 2022 underwent physical-chemical characterisation followed by fermentation to produce flammable biogas, the methane content of which was determined. The HWS1 reactor gave a low methanogenic potential of $14.81 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$ compared with the HWS2 reactor of $26.33 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$. The (HWS+L) reactors were mixed at a VM leachate/substrate ratio of 0.5, in order to optimize production. As a result, the (HWS1+L) mixing reactor gave a low methanogenic potential of $46.22 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$ compared with the (HWS2+L) mixing reactor of $59.28 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$. The evolution and physico-chemical composition of the reaction media made it possible to monitor the progress of the experiments. It was concluded that wet-season substrates produce less biogas than dry-season substrates, and that the leachate can be used to increase the biogas rate, with the idea of valorising it.

Keywords: landfill, methanogenic potential, waste massifs, biogas, leachate

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1. Introduction

Our society's changing lifestyles are leading to a significant increase in waste production worldwide. Among the various treatment and/or disposal processes, landfilling is the oldest and still the most widespread [1]. While waste storage is common practice in industrialised countries, with varying degrees of control, this is not the case in developing countries [2]. This shortfall is due partly to a lack of financial resources and partly to poor organisation [3]. In developing countries, landfill is the final destination for over 90% of the waste collected [4]. In Togo, landfilling is also a disposal technique for Household Waste and Similar (HWS). In 2018, the Agoè-Nyivé landfill was abandoned due to

saturation and urban expansion. So, to meet this growing need, a Technical Landfill Center (TLC) was built in Aképé, 20 km from Lome. It is the fruit of a partnership between the Togolese government, the Agency French of Development, the European Union and the West African Development Bank. It has a capacity of 250,000 to 350,000 tonnes of waste per year. Due to its instability and evolutionary nature, HWS poses major environmental problems, and contains a significant quantity of organic matter which, under storage conditions, is transformed (biophysically and chemically) into soluble compounds that give rise to leachates under the action of water, and gaseous compounds that are easily mobilised (biogas) [5]. For example, the requirement to install a watertight layer between the soil and the waste prior to operation, and to treat leachates, has led to a significant reduction in water and soil pollution [1]. Today, the Aképé landfill site has

considerably reduced water infiltration into the massif, and liquid (leachate) and gaseous (biogas) emissions that are harmful to our environment. However, the recovery of these products (biogas and leachate) from the center is becoming problematic. The biogas is simply flared off, while the leachate is discharged back into the environment after being treated in basins coupled with reed filters. Given the quantity of household and similar waste landfilled each year, the high organic [4] of HWS and biogas generated at non-hazardous waste landfills [6]; the study of the methanogenic potential of biogas with energy recovery may be of interest for household and similar waste and leachate from the Aképé TLC. But before biogas can be valorised, its production needs to be optimised, and this can be done through the Biochemical Methane Potential (BMP) test.

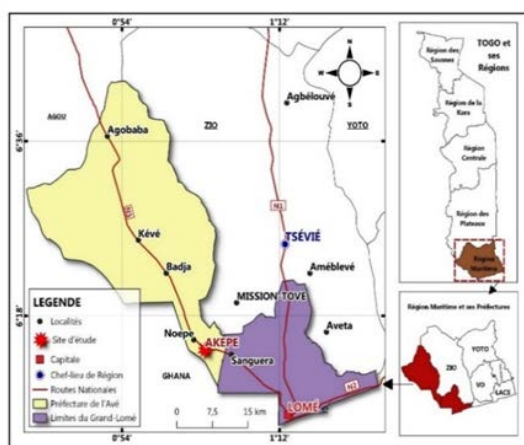


Figure 1. Site location

2. Materials and Methods

2.1. Presentation of the Aképé TLC

The Technical Landfill Center of Aképé, site of the present study, is a class II (Non-hazardous waste storage facilities). Inaugurated in 2018, the TLC is located in the maritime region (South-Togo), more precisely in the Avé prefecture (Figure 1) at 20 km from Lomé between 06°13'44.3" North and 01°04'38.7" East, covering an area of 194 hectares. To date, the TLC has only one bin subdivided into eleven (11) geomembrane cells composed of three layers, namely: geo-bentonite membrane, high-density polyethylene membrane and an anti-ultraviolet (UV) geotextile. In 2022, the landfill received around 323,000 tonnes of municipal solid waste (MSW) from collection companies. These wastes are conveyed to the landfill (Figure 2) after verification of the origin and weight of the waste to be buried.

2.2. Physical-chemical Characterization of Substrates

The organic fraction of the household waste and similar mass (food waste (FW), green waste (GW), paper and cardboard (PC), wood (WO) and fines (FN)), to which the treated leachate from the TLC was added, was studied. The composite sample (triplicate) of the waste mass,

which takes into account the seasonal nature (rainy season (June) and dry season (August) 2022) of the production and organization of waste collection in the 13 Municipalities of Greater Lomé, is taken from trucks arriving in the bin after homogenization and before stacking, then characterised according to the Household Waste characterisation method) recommendation [7].



Figure 2. Status of the Technical Landfill Center locker

Samples of treated leachate from the CET, collected in hermetically sealed PVC bottles and stored in a dark refrigerator at $4.5 \pm 0.5^\circ\text{C}$, are used primarily as inoculum for the experiments [8]. These samples are characterized in triplicate in terms of pH, Conductivity, Moisture (%H), Dry Matter (DM), Volatile Matter (VM) or Organic Matter (OM), Total Organic Carbon (TOC), Total Kjeldahl Nitrogen (TKN), Total Alkalimetric Title (TAC), Volatile Fatty Acids (VFA), C/N and VFA/TAC ratios required to launch digestion tests.

The pH was measured using a HANNA Instruments pH meter (HI2210) in accordance with the following standards [9] for the liquid phase and the standard [10] for the solid phase. The Moisture (%H) and Dry Matter (DM) are determined by drying a few grams of the organic fraction of the waste mass at a temperature of 105°C over a period of 24 hours, after passage through the ISUZU oven. The Organic Matter (% OM) or volatile Matter (% VM) content is obtained by the loss on ignition method. After oven-drying at 105°C , the sample is placed in an oven (SNOL 40I1200) at 550°C for 2 hours [11]. Total Organic Carbon (TOC) is estimated using the formula [12]:

$$\text{TOC} = \frac{\text{VM}}{1,724} \quad (1)$$

Total Kjeldahl nitrogen (TKN) was measured using the method described by the «Association of Official Analytical Chemists» [13] and the method described by [14] respectively on solid phase and aqueous samples. These techniques were carried out in three stages: sample mineralization, ammonia distillation and ammonia titration. Total Alkalimetric Titrers (TAC) and Volatile Fatty Acids (VFA) are determined on leachates and effluents using the potentiometric method described by [15]. Conductivity was determined using a conductivity meter (WTW Cond 3110), with integrated temperature measurement for automatic compensation of the conductivity value according to the solution temperature standard [16]. Leachate redox potential was measured using a WTW multimeter. The associated measurement standard is [9].

Table 1. Details of substrates introduced into BMP reactors

Characteristics			Reactor with inoculum		Reactor Without inoculum	
			RPL (HWS1+L)	RSL (HWS2+L)	RPSL (HWS1)	RSSL (HWS2)
Mass of waste (kg)×10 ⁻⁴	FW	Big	8.72	4.24	8.72	4.24
		Medium	1.47	1.93	1.47	1.93
	GW	Big	3.75	3.90	3.75	3.90
		Medium	5.55	6.88	5.55	6.88
	PC	Big	0.73	0.79	0.73	0.79
		Medium	0.27	0.20	0.27	0.20
	WO	Big	1.63	1.45	1.63	1.45
		Medium	0.5	0.43	0.35	0.43
	FN		11.20	14.45	11.20	14.45
	Total weight (g)		33.67	34.27	33.67	34.27
Initial water (mL)		150	150	75	75	
Initial leachate (mL)		240.60	240	-	-	
Ratio L/S		0.5	0.5	-	-	



Figure 3. Device for producing biogas and methane volumes

then sealed. Biogas production was measured by displacing a solution of acidified water at pH = 2 using an inverted test tube (Figure 3). The use of acidified water prevents the dissolution of CO₂ from the biogas [6]. The methane content is measured by displacing the liquid using a NaOH solution (pH=13) which traps the CO₂ [24]. The bottles are shaken manually once a day.

The experiments were stopped after 30 days of production when daily biogas production was very low. Two tests (Table 1) were carried out, all in duplicate:

- Test 1 (rainy season): 33.67 g of waste or 13.96 g_{VM} with 240.60 mL of leachate or 6.98 g_{VM} noted RPL.
- Test 2 (dry season): 34.27 g of waste or 13.92 g_{VM} with 240 mL of leachate or 6.96 g_{VM} noted RSL.
- 100 mL control flasks, into which only wet waste was introduced, to determine the production of the waste mass noted RPSL and RSSL.

2.3. The BMP Test for Organic Fractions in the Waste Mass and Leachate

The aim of this experiment is to evaluate the methanogenic production of the organic fraction of the waste mass in the presence of inoculum, which helps the substrate to rapidly achieve optimal conditions, in particular the supply of nutrients, microbial flora and stabilisation of the pH at 7, in accordance with the guidelines of the standard [17] with adaptation of the inoculum. The inoculum used is treated leachate from the technical landfill, because of its positive effect on waste degradation, but also because of its capacity to rapidly convert a large quantity of organic matter contained in the waste into methane and carbon dioxide [18-19] reducing the accumulation of ammoniacal nitrogen, the main non-biodegradable pollutant [20]. A mass (< 2 mm) of wet waste respecting the proportions of the fractions of food waste, green waste, paper-cardboard, wood and fine elements within the waste mass, are introduced into 500 mL flasks in contact with the inoculum (leachate) in such a way that the leachate/substrate ratio (L/S) in kgVM/kgVM corresponds to the ratio between the quantity of leachate and the quantity of substrate initially introduced into a reactor. An L/S ratio of 0.5 was chosen to optimise microbial activity [21-23]. Distilled water at pH = 7 is used to bring the volume of the flask up to 80%,



Figure 4. Device for monitoring the reaction medium

2.4. Monitoring the Reaction Environment of the BMP Assay

Monitoring of the reaction environment is necessary to ensure that the tests run smoothly. For example, for the BMP tests, monitoring the reaction medium requires large quantities of liquid phase which, when taken from the 500 and 100 mL bottles, could alter the volume production monitored [24]. For this reason, larger 10 L reactors (Figure 4) are used to sample the liquid phase and monitor parameters such as pH, conductivity, temperature, redox potential and VFAs. These 10 L reactors are carried out under the same conditions as the BMP tests (L/S = 0.5 kgVM/kgVM), the only difference being that the waste mass is twice as large and the volume of distilled water added is 8 L.

3. Results and Discussion

3.1. Physico-chemical Characterisation of Substrates

3.1.1. The Organic Fraction of Massifs Waste

Preliminary characterisation of the substrates is essential and is assessed in terms of pH, DM rate, MV rate and C/N ratio. These parameters are listed in Table 2.

Table 2. Global characterisation of substrates

Parameters	Rainy season HWS1	Dry season HWS2
pH	7.33 ± 0.02	7.47 ± 0.02
%H	30.34 ± 3.62	27.22 ± 5.21
DM (% _{DM})	69.66 ± 3.62	72.78 ± 5.21
VM (% _{DM})	41.47 ± 2.06	40.59 ± 0.71
TOC (g/kg _{DM})	240.55 ± 11.94	235.44 ± 4.11
TKN (g/kg _{DM})	17.50 ± 1.00	16.10 ± 0.50
Ratio C/N	13.75 ± 1.00	14.62 ± 0.70

The pH of the substrates, ranging from 7.33 to 7.47, are neutral and will be easily digested. The DM rates are higher than 69% for HWS1 and 72% for HWS2. This slight increase of 3% is due to the fact that HWS1 comes from the rainy season and therefore has a low DM content compared to HWS2 from the dry season. This means that HWS1 has a higher water content than HWS2. The reference [12] reported an average difference of 10% for household waste from the dry and rainy seasons. The VM content was 41.47%_{DM} for HWS1 and 40.49%_{DM} for HWS2. These VM rates, which are of the order of 40%_{DM}, are low compared with the reference studies [12] which are on average in the order of 72-80%_{DM} of the waste from the households. These low rates would be due not only to the fact that waste passes through transit sites but also to a high percentage of fine elements in the HWS, and whose MV rate is less than 40%_{DM} of the waste in the final landfill [12]. Both substrates have a C/N of between 13 and 15, indicating an excess of nitrogen. The ideal C/N ratio for anaerobic digestion should be between 20 and 30 [25]. A low C/N value represents a large quantity of nitrogen as well as a small quantity of carbon used in the digestion process, sometimes producing ammonia, which

is toxic for the environment [26]. The substrates have a C/N that is unsuitable for methanisation, so an assessment of the parameters means that co-digestion can be undertaken [27] and this must be done using BMP tests.

3.1.2. Treated leachate

The aim of characterising the treated leachate is to obtain information on its quality and to assess the effectiveness of the microbial flora potentially available in the inoculum. The results are shown in Table 3.

Table 3. Characterisation of treated leachate

Parameters	Treated leachate from TLC
pH	8.84 ± 0.03
VM (g _{VM} /L)	0.87 ± 0.01
TOC (g/L)	0.50 ± 0.01
TKN (g/L)	14.00 ± 0.70
VFA (g/L)	0.24 ± 0.01
TAC (g/L)	4.52 ± 0.02
Ratio C/N	0.04 ± 0.01
Ratio VFA/TAC	0.05 ± 0.01

The pH of the treated leachate is basic at around 8.84 ± 0.03. The optimum operating range for anaerobic digestion is between 6.5 and 8 [28-29]. The pH values above 8.5 are toxic for methanogenic bacteria [30]. This result is correlated by a C/N ratio equal to 0.04 ± 0.01. As this ratio is very low, nitrogen will be released and accumulate in the form of ammonium. Excessive ammonium formation therefore leads to an increase in the pH of the medium through the formation of the NH₃ form. To these we add a low value of 0.87 ± 0.01 g_{VM}/L of VM due to the fact that the leachate has been treated. These parameters indicate that the leachate is not suitable for anaerobic digestion. However, analysis of the TAC and VFA gives 4.52 ± 0.02 g/L and 0.24 ± 0.01 g/L respectively, which are suitable values. In fact, a minimum TAC of 2 g/L [31] and a maximum VFA of 3 g/L [32] are recommended to ensure that the anaerobic digestion process runs smoothly. In addition, an optimum VFA/TAC ratio of less than 0.8 is recommended [31-32]. This ratio, of the order of 0.05 ± 0.01, shows that the inoculum contains a microbial flora adapted to biogas production.

3.2. Study of the BMP of Substrates with and Without Inoculum

3.2.1. Reactor Without Inoculum

After 30 days, the average cumulative intrinsic biogas production of the RPSL (HWS1) (Figure 5) and RSSL (HWS2) (Figure 6) reactors was 14.81×10⁻³ m³_{Biogas}/kg_{VM} and 26.33×10⁻³ m³_{Biogas}/kg_{VM} respectively. The volume productions of biogas are relatively far apart. These differences suggest that dry-season substrates make more organic matter available than rainy-season substrates. This can be explained by the fact that the substrates from the rainy season have already begun the degradation process, so some of the biogas has already been produced. However, this production seems to be too low compared with the pineapple substrates studied by Tcha-Thom [6]

which showed productions of the order of $780 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$. These low rates can be justified by the fact that HWS 1 and 2 have a VM rate of around $40\%_{\text{DM}}$, compared with pineapple substrates of around $99 \pm 1\%_{\text{DM}}$.

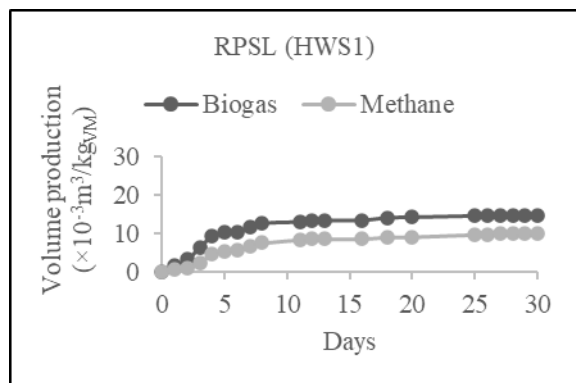


Figure 5. Evaluation of HWS1 production

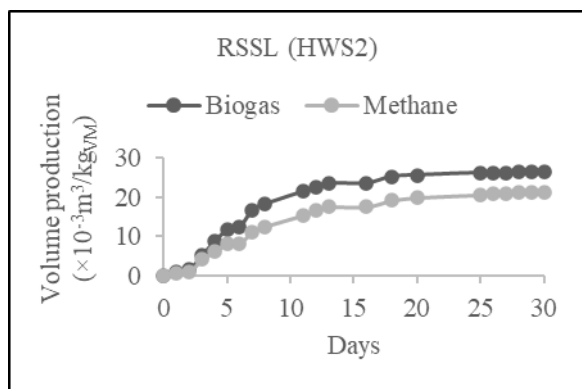


Figure 6. Evaluation of HWS2 production

The methane concentration in the RPSL (HWS1) and RSSL (HWS2) reactors is around 67.31% and 80.25% respectively. These methane contents are too high compared with the Tanios experiments [33] whose methane content varies between 46.7 and 50.9%. However, the methane content in biogas from organic waste can vary from 45 to 80% [33].

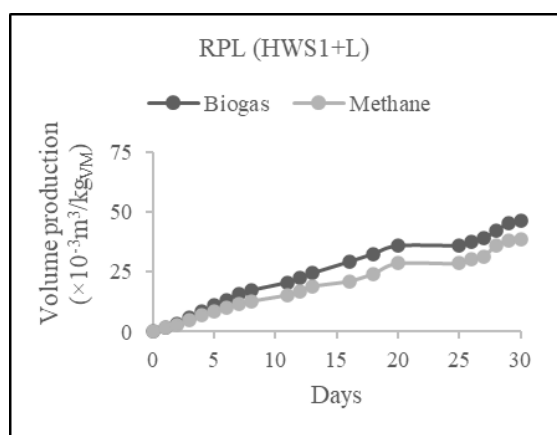


Figure 7. Evaluation of (HWS1+L) production

3.2.2. Reactor with Inoculum

The (Figure 7) and (Figure 8) show the average cumulative biogas production of the RPL (HWS1+L) and RSL (HWS2+L) reactors after 30 days. The volume

productions of the RPL and RSL reactors were $46.22 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$ and $59.28 \times 10^{-3} \text{ m}^3_{\text{Biogas}}/\text{kg}_{\text{VM}}$ respectively. Although these yields are low, they appear to be higher than those from reactors without inoculum. This increase is due to the presence of the inoculum. In fact, the addition of a seeding inoculum at the start of the BMP tests provides an active microbial biomass that avoids cases of inhibition and promotes a state of equilibrium in the whole anaerobic digestion process [34].

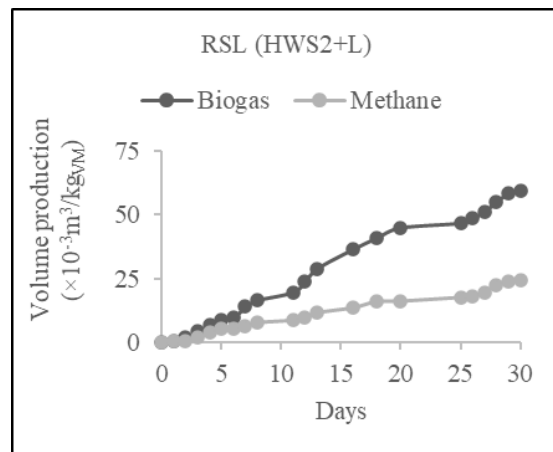


Figure 8. Evaluation of (HWS2+L) production

The methane contents of the RPL (HWS1+L) and RSL (HWS2+L) reactors are 83.18% and 41.30% respectively. The methane content of the RSL reactor is similar to that of the experiments by Rani and Nand [35] whose methane content varies between 31 and 50%, and that of the RSL reactor seem to be too high, correlated by studies of the digestion of pineapple fruit waste [6], which found methane levels of around 89%, a percentage that was due to the simultaneous addition of ash and cow dung [6].

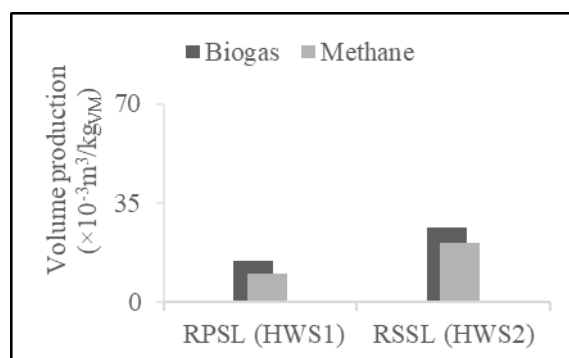


Figure 9. Productions without inoculum

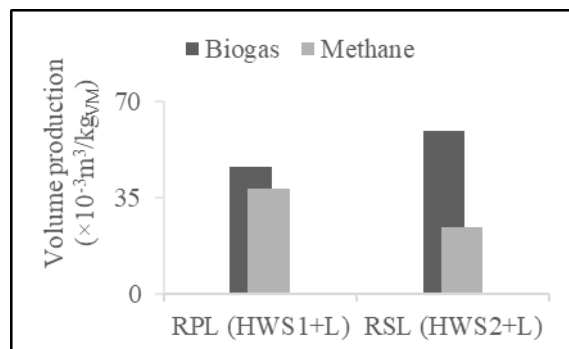


Figure 10. Productions with inoculum

3.2.3. Effect of Leachate on Biogas and Methane Production

The (Figure 9) and (Figure 10) show the volume production of biogas and methane in the reactors without and with inoculum respectively. The volume production of the RPSL reactor (HWS1) is $14.81 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ with $9.97 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ (67.31% methane) and that of the RSSL reactor (HWS2) is $26.33 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ with $21.13 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ (80.25% methane). In parallel with the volume production of the reactors without inoculum, the volume production of the reactors with inoculum gave $46.22 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ with $38.45 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ (83.18% methane) and $59.28 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ with $24.48 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ (41.30% methane) respectively for the RPL (HWS1+L) and RSL (HWS2+L) reactors. The leachate thus increased volume production from $31.41 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ for HWS1 substrates to $32.95 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ for HWS2 substrates and from $28.48 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ for HWS1 substrates to $3.35 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ for HWS2 substrates. This increase is greater than $31 \times 10^{-3} \text{ m}^3 \text{ Biogas/kg}_{\text{VM}}$ for biogas from both substrates. However, for methane, the increase is greater than $28 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ for HWS1 substrates and greater than $3 \times 10^{-3} \text{ m}^3 \text{ methane/kg}_{\text{VM}}$ for HWS2 substrates. The reference [24] report that the presence of inoculum accelerates quantitative biogas production and improves biogas quality.

3.3. Physico-chemical Characterisation of Reactors

3.3.1. Ambient and Reactor Temperatures

Temperature monitoring is used to ensure that the substrate degradation process is triggered and anaerobic digestion begins. The temperatures recorded varied between 27.8 and 32.3°C for the RPSL (HWS1) reactor (Figure 11a), between 27.9 and 31.9°C for the RSSL (HWS2) reactor (Figure 11b), between 27.8 and 31.9°C for the RPL (HWS1+L) reactor (Figure 11c) and between 27.7 and 31.9°C for the RSL (HWS2+L) reactor (Figure 11d).

The experiments were conducted at room temperature (between 25.5 and 30.6°C) to stimulate natural conditions in a tropical environment. The analytical results show that all the reactors operated in the mesophilic fermentation range (22–40°C) [36]. The low temperatures of the reactors compared to the optimum digestion temperature, 35°C in mesophilic conditions [6], would have a negative influence on the performance of anaerobic digestion, resulting in a reduction in the level of degradation and qualitative production of methane in RSL.

3.3.2. pH and VFA

The pH values recorded varied between 6.7 and 7.6 for the RPSL (HWS1) reactor (Figure 12a), between 6.7 and 7.8 for the RSSL (HWS2) reactor (Figure 12b), between 6.9 and 8.6 for the RPL (HWS1+L) reactor (Figure 12c), and between 7.2 and 8.7 for the RSL (HWS2+L) reactor (Figure 12d).

The analytical results show that the reactors without inoculum operated in the pH range 6.7–7.8 and those with inoculum in the range 6.9–8.7. According to [29], the pH must be between 6.5 and 8 for good fermentation without inhibition, which justifies the good operation of

the digesters. However, the RPL and RSL reactors had a pH higher than 8 between the start-up day and the 2nd day. This can be explained by the fact that the leachate had a pH of around 8.84. The reference [37] reports pH values in biodigesters of 6.3 and 8.7, which are comparable to the values in this study.

In parallel with the pH values, the evolution of VFA in the reactors (Figure 13a) and (Figure 13b) shows an increase from the beginning to day 12 followed by a decrease until the end of the trials. This increase up to day 12 followed by a decrease up to day 30 is correlated with a decrease in pH followed by its re-increase over the same period. In fact, the main cause of acidification of the environment is the accumulation of volatile fatty acids [38] and the increase in pH is justified by the over-consumption of VFA for biogas production. After 30 days, VFAs were below 3 g/L in all the reactors. A VFA concentration of less than 3 g/L is recommended for the reactors to function properly [32].

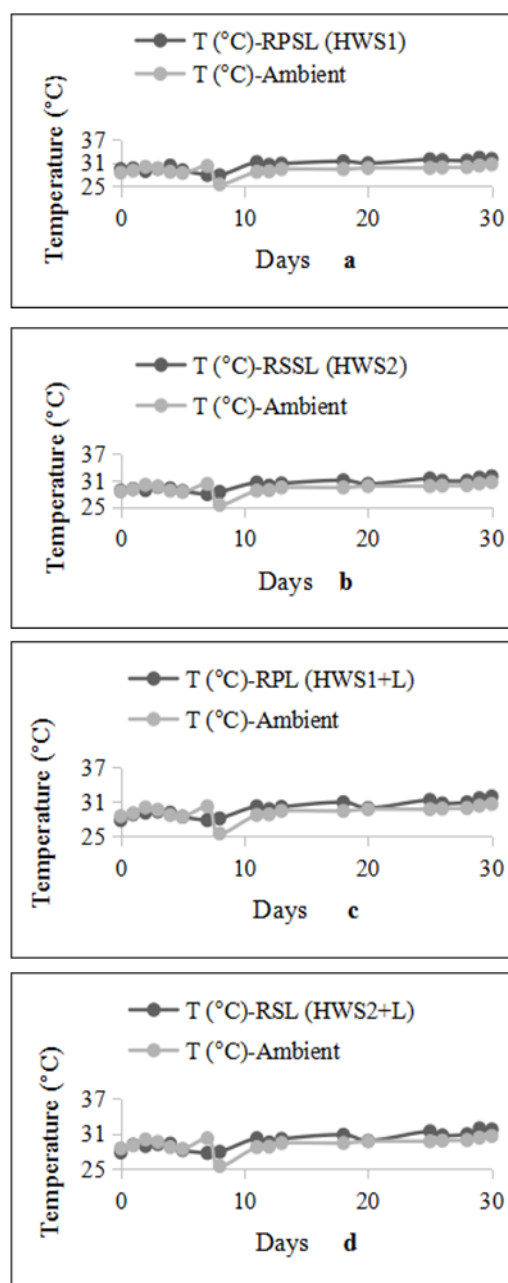


Figure 11. Daily variations in reactor temperatures

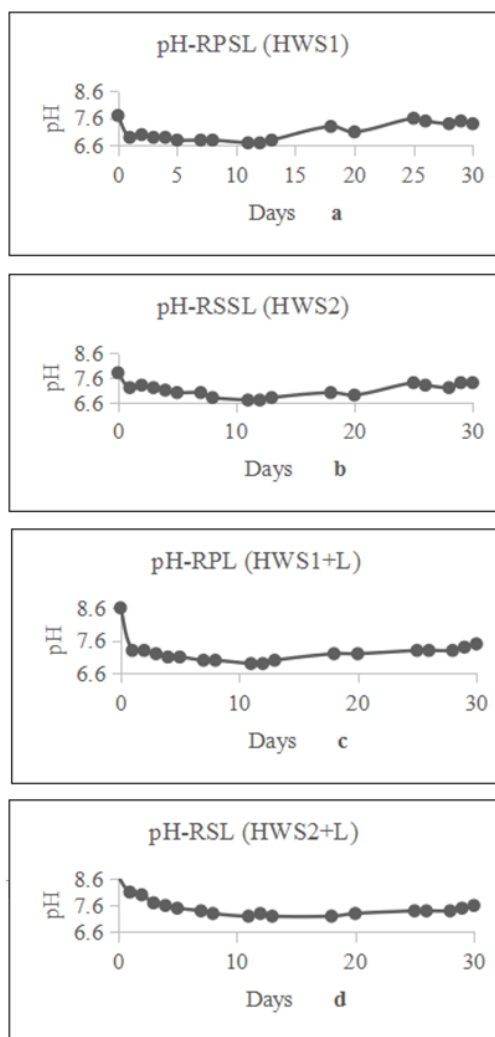


Figure 12. Daily variations in pH in the reactors

3.3.3. Conductivity

The conductivity measurement provides overall information on the quantity of charged species present in the various reactors. The conductivity (Figure 14a) and (Figure 14b) varies between 1428 and 1693 $\mu\text{S}\cdot\text{cm}^{-1}$ for RPSL (HWS1), between 1514 and 1751 $\mu\text{S}\cdot\text{cm}^{-1}$ for RSSL (HWS2), between 2180 and 2760 $\mu\text{S}\cdot\text{cm}^{-1}$ for RPL (HWS1+L), and between 2610 and 2820 $\mu\text{S}\cdot\text{cm}^{-1}$ for RSL (HWS2+L). The average conductivity was 1622 $\mu\text{S}\cdot\text{cm}^{-1}$ for RPSL, 1662 $\mu\text{S}\cdot\text{cm}^{-1}$ for RSSL, 2593 $\mu\text{S}\cdot\text{cm}^{-1}$ for RPL and 2746 $\mu\text{S}\cdot\text{cm}^{-1}$ for RSL. These results show an average conductivity greater than 1600 $\mu\text{S}\cdot\text{cm}^{-1}$ in all the reactors, and these values are more pronounced at around 1000 $\mu\text{S}\cdot\text{cm}^{-1}$ in the reactors with inoculum. The reference [39], reports that the lower the conductivity, the more advanced the state of degradation. And the more advanced the state of degradation of the substrate, the lower the volume production of biogas [40], which would justify the difference in biogas volume production observed in this study. The high values observed in the reactors with inoculum can be explained by the accumulation of charged species due to the addition of leachate.

3.3.4. Redox potential

The redox potential rapidly decreased and stabilised between -40mV and -60mV for the RPSL and RSSL

reactors (Figure 15a), and between -60mV and -80mV for the RPL and RSL reactors (Figure 15b). It is used to ensure that reducing conditions favourable to anaerobic digestion are in place, and its minimum optimum value is -250 mV. These recorded values are much higher than the optimum value. A value greater than -200 mV is inhibitory and can interrupt methane production. This would explain the low volume production rate in the reactors.

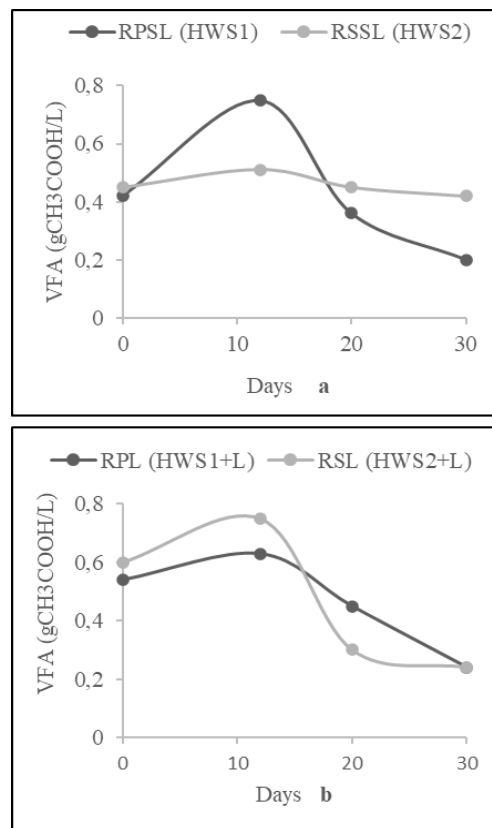


Figure 13. Daily variations in VFAs in reactors

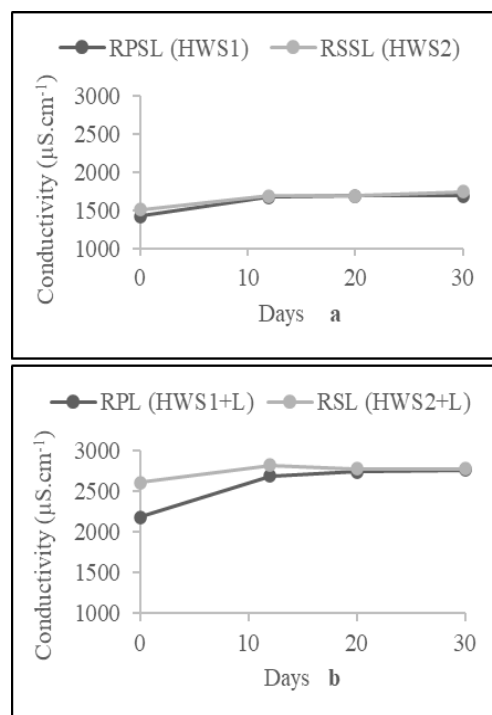


Figure 14. Daily variations in conductivity in the reactors

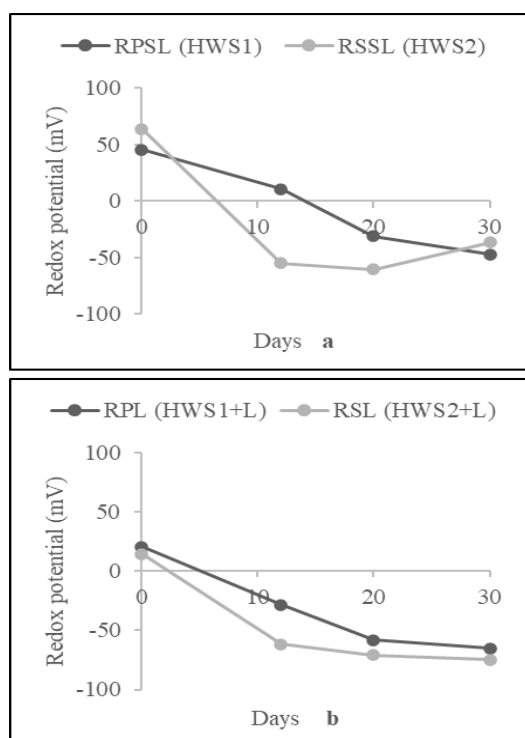


Figure 15. Daily variation in reactor redox potential

4. Conclusion

The aim of this study was to assess the methanogenic potential of the organic fraction of household and similar waste from the Aképé Technical Landfill Centre (TOGO). At the end of the tests, it was found that the substrates had an organic matter content that could be recovered by anaerobic digestion in the presence of treated leachate used as an inoculum to overcome the problem of its storage. The experimental results showed that the reactors operated within the optimum pH and mesophilic temperature range. Under TLC storage conditions, biogas production can be inhibited by a number of factors, including pH, temperature, VFA, conductivity and redox potential, which in anaerobic digestion are monitored and potentially controllable. This study has shown that controlling these parameters and using the leachate as inoculum can optimise biogas production, with the idea of being able to recover this biogas in the form of energy, which is burnt through a flare.

Conflict of Interest

The authors have declared no conflicts of interest.

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