Revue-IRS

Revue Internationale de la Recherche Scientifique
(Revue-IRS)
ISSN: 2958-8413
Vol. 4, No. 4, Juillet 2026

Anaerobic co-digestion of chicken manure and banana fiber extraction sludge for sustainable agricultural waste management

Emilienne Laure Ngahane

Agro-Environnemental Analysis Laboratory, Higher Institute of Agriculture, Forestry, Water resources and Environment, University of Ebolowa (HIAFWE, UEb), PO. BOX 118 Ebolowa, Cameroon;

Junior Maimou Nganko

African Center of Excellence for the Valorization of Waster into High Value Products (CEA-VALOPRO), World Bank Excellence Center, Félix Houphouet-Boigny National Polytechnic Institute (INP-HB), BP:1093, Yamoussoukro, Ivory Coast;

Stéphane Kenfack Lontsi

Energy and Sustainable Development Laboratory, Higher Institute of Agriculture, Forestry, Water resources and Environment, University of Ebolowa (HIAFWE, UEb), PO. BOX 118 Ebolowa, Cameroon;

Fabrice Mbakop Kwefeu

Energy and Sustainable Development Laboratory, Higher Institute of Agriculture, Forestry, Water resources and Environment, University of Ebolowa (HIAFWE, UEb), PO. BOX 118 Ebolowa, Cameroon;

Abstract: At the training farm of the Higher Institute of Agriculture, Forestry, Water resources and Environment of the University of Ebolowa-Cameroon, animal products and plant products are produced. Problem arises in the management of post-harvest crop residues and livestock effluent. To support their improved management, a local experimental study was conducted on the anaerobic co-digestion of chicken manure and sludge derived from banana pseudo-trunk fiber extraction. A batch mesophilic digester (36.33 ± 0.89 °C) with a working volume of 90 L was used. The substrate consisted of 20 kg of chicken manure, 40 kg of banana fiber extraction sludge, and 20 kg of water. Prior to digestion, the physicochemical characteristics of the co-substrates were analyzed, and biogas and digestate production were monitored throughout the process. Chicken manure showed a high dry matter content (85.8 ± 0.93%), was rich in organic matter (72.05% DM), and had a relatively high nitrogen content (Nt = 2.99 ± 0.18%; C/N = 10.4 ± 0.42). In contrast, banana fiber extraction sludge was highly liquid (95.37 ± 0.78% water), rich in organic matter (83.52% DM), and carbon-rich (C/N = 104.9 ± 4.61), making it significantly different but complementary to chicken manure. The overall substrate composition was 23.77 ± 0.39% DM, 17.39 ± 0.24% % OM, and 0.76 ± 0.05% total nitrogen. After 31.67 ± 0.89 days of digestion, 2.12 ± 0.10 Nm^3 of biogas containing 64.65 ± 1.72% methane and 57.33 ± 2.22 kg of digestate were produced. Biogas productivity reached 188 ± 9 Nm^3/t OM. These results demonstrate that co-digestion generates methane-rich biogas and nutrient-rich digestate, offering a sustainable solution for waste treatment, renewable energy production, and biofertilizer recovery.

Keywords: crop residue, livestock effluent, valorization, methanization, biogas, biofertilizer.

Digital Object Identifier (DOI): https://doi.org/10.5281/zenodo.21208820

1 Introduction

Sustainable agricultural waste management has become a critical challenge in the context of climate change, energy transition, and the intensification of agricultural production systems. The increasing generation of crop residues and livestock effluents requires innovative and locally adapted solutions that not only mitigate environmental impacts but also contribute to renewable energy production and nutrient recycling. Anaerobic digestion (AD) has emerged as a key technology in this regard, offering the dual benefits of biogas generation and digestate production for soil amendment. As part of the teaching farm expansion project at the Higher Institute of Agriculture, Forestry, Water resources and Environment (HIAFWE) of the University of Ebolowa, integrated agricultural waste management has been identified as a strategic priority. In particular, the valorization of crop residues and livestock effluents is increasingly promoted as a means to supports sustainable agroecosystems, local energy production, and the circular economy. Within this framework, the development of local expertise and experimental platforms to anerobic digestion is rapidly gaining importance.

Among the organic waste generate at the teaching farm, chicken manure from the poultry unit and fiber extraction sludge from experimental banana pseudo-stem valorization station were selected for co-digesting. Chicken manure is widely recognized as a highly methanogenic substrate with significant biogas production potential due to its high organic matter content (Linas et al., 2020; Levasseur et al., 2022). However, its elevated nitrogen content and low carbon-to-nitrogen (C/N) ratio make poultry manure unsuitable for mono-digestion, as these characteristics can lead to ammonia inhibition and process instability, while also limiting its direct use as an effective fertilizer (Barbaux, 2023; Pountounynyi et al., 2025). To overcome these constraints, co-digestion with other carbon-rich organic matter is commonly adopted as an effective strategy for optimizing anaerobic digestion performance (Barbaux, 2023). In this regard, lignocellulosic agricultural residues represent promising co-substrates due to their high carbon content and wide availability (Tawfik et al., 2023). Therefore, the addition of banana pseudo-stem fiber extraction sludge, available on-site, to the chicken manure proved suitable for the experiment. Indeed, banana pseudo-stems contain a significant amount of organic matter and fibrous components and have demonstrated a non-negligible methanogenic potential (Kamdem et al., 2011; Adannou et al., 2025; Ngahane et al., 2026). Nevertheless, their high C/N ratio limits their suitability for anaerobic digestion when used alone, thereby justifying their combination with nitrogen-rich substrates such as chicken manure (Soheil et al., 2017).

The co-digestion of chicken manure with banana pseudo-stem fiber extraction sludge thus offers a complementary substrate combination that promotes nutrient balance, enhances biodegradability, and improves the overall stability of the anaerobic digestion process. This approach aligns with the objectives of sustainable agricultural waste management and renewable energy recovery, particularly in tropical regions where such residues are abundant and often underutilized. The general objective of this study is the development the learners' capacity to act for local development, ecological transition, and the circular economy implementation within agroecosystems through improved agricultural waste management. Specifically, this study aims to analyze the physicochemical characteristics of the co-substrates (chicken manure and banana fiber extraction sludge). Also, was implemented anaerobic digestion of these co-substrates under control conditions with biogas and digestate characterization.

2 Materials and methods

2.1 Analysis of Co-substrates

Chicken manure and banana pseudo-stem fiber extraction sludge were collected from the training farm of the Higher Institute of Agriculture, Forestry, Water resources and Environment (HIAFWE), University of Ebolowa (Fig. 1). Three representatives' samples of banana fiber extraction sludge and chicken manure where taken following standard sampling procedures and analyzed at the Agro-Environmental Analysis Laboratory (AEAL) of HIAFWE.

Moisture content (%H_2O) and dry matter (%DM) where determined by oven drying 105°C until constant mass, while organic matter (%OM) and mineral matter (%MM) were measured by ignition at 550°C, according to standard analytical protocol (APHA, 2017). Organic carbon (%CO) was estimated from organic matter content using conventional conversion factors, and total nitrogen (%Nt) was determines using the Kjeldahl method, which is widely applied in anaerobic digestion studies (Ward et al., 2008).

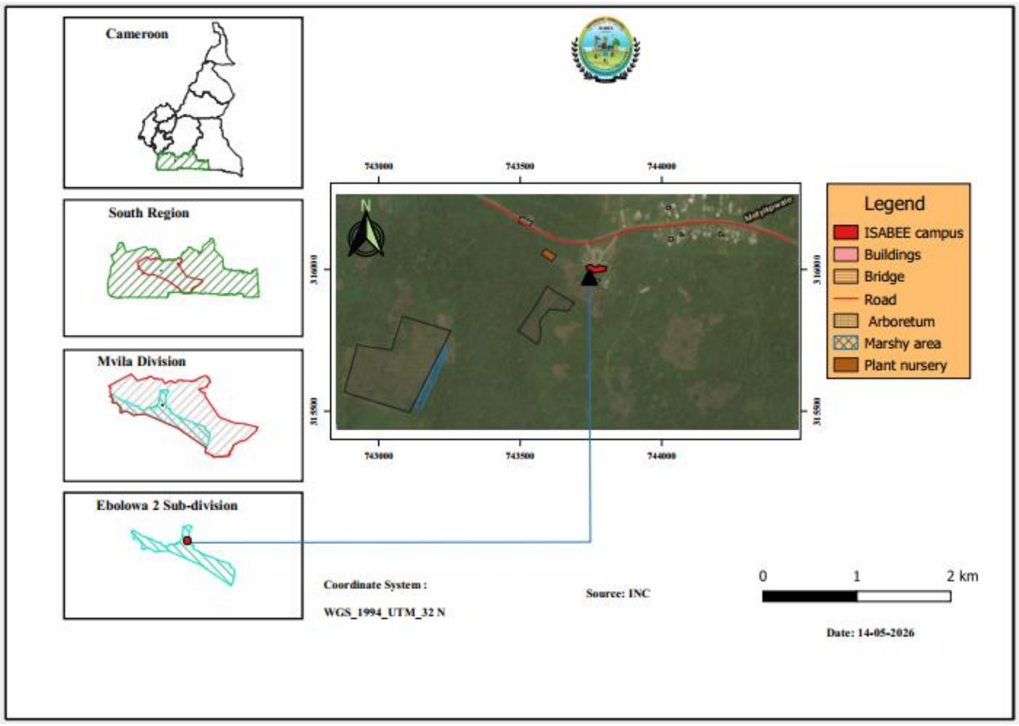

Figure 1. Location map of the HIAFWE's training farm.

2.2 Anaerobic co-digestion experiment

The substrate introduced into the anaerobic digester consisted of a mixture of: 20 kg of chicken manure, 40 kg of banana fiber extraction sludge, 20 kg of water; three repetitions were done.

The equivalent composition of the mixture expressed as percentage ($\dot{P}$) and mass ($\dot{M}$) of each constituent was calculated using equations 1 and 2, following mass balance principles commonly applied in anaerobic digestion studies (Angelidaki et al., 2009):

$$\dot{P}x = \frac{\left(P_{x_{Chicken\ manure}} \times M_{Chicken\ manure}\right) + \left(P_{x_{Sludge}} \times M_{Sludge}\right) + \left(P_{x_{Water}} \times M_{Water}\right)}{M_{Chicken\ manure} + M_{Sludge} + M_{Water}} \quad (1)$$

Where: $\dot{P}x$ represents content of constituent x (%) in the substrate to be digested.

$P_{xChicken\ manure}$, $P_{xSludge}$, P_{xWater} are respectively content of constituent x (%) in manure, in sludge, and in water.

$M_{Chicken\ manure}$, M_{Sludge}, M_{Water} are respectively mass (kg) of manure, sludge, and water.

$$\dot{M}x = \frac{\dot{P}x \times (M_{Chicken\ manure} + M_{Sludge} + M_{Water})}{100} \quad (2)$$

Where $\dot{M}x$ is mass of constituent x (kg) in the substrate to be digested.

The load applied in the digester ($\bar{A}$) was calculated using equation 3 as recommended for evaluating digestion intensity in batch systems (Mata-Alvarez et al., 2009):

$$\bar{A} = \frac{M_{OM}}{Vu} \quad (3)$$

Where $\bar{A}$ is the load applied to the digester (t OM/m^3 Digester), MOM is the mass of organic matter introduces in the digester (kg) and Vu is the usable volume of the digester (90 L).

2.3 Experimental setup

Anaerobic co-digestion was carried out in batch-type biodigester operated under mesophilic conditions at average ambient temperature of 36.33 ± 0.89 °C, a configuration commonly used for experimental and pilot-scale studies Ward et al., 2008). The system consisted of a cylindrical 100-liter drum equipped with a sealed lid and two upper openings discharge. An additional 10-cm-diameter lateral opening was installed on the side wall of the reactor at approximately one-third of its height to allow digestate sampling and discharge.

The gas collection system comprised PVC pipes, controls valves, and sealing accessories to ensure airtight conditions. Biogas production was monitored using a gas meter coupled with a pressure gauge, while the produces biogas was stored in a flexible rubber bladder.

2.4 Monitoring, characterization of digester outputs and statistical anaysis

Daily biogas production (V_{Biogas}) was recorded until complete substrate degradation following recommendations for batch digestion monitoring (Angelidaki et al., 2009). The methane concentration (%CH_4) was measured daily using a portable methane analyzer (TY20200102339001 made in SHENZHEN TEENWIN ENVIRONMENT CO.LTD). The weighted average methane content ($\dot{X}_{CH4}$) was determined using equation 4, as proposed in biogas performance assessment studies (Mata-Alvarez et al., 2009):

$$\dot{X}_{CH4} = \frac{\Sigma(V_{D,Biogas} \times X_{D,CH4})}{V_{Biogas}} \quad (4)$$

Where $V_{D,Biogas}$ is daily biogas volume (Nm^3), $X_{D,CH4}$ the corresponding methane fraction (%) and V_{Biogas} the total biogas produced volume (Nm^3).

The digestate from the anaerobic biodigester was collected, weighed and sampled for physicochemical analysis at the AEAL. The same analytic methods applied to the input substrate were used to determinate %H_2O, %DM, %OM, %MM, %CO and %Nt ensuring consistency between input and output characterization (APHA, 2017).

The variation in constituents (ΔX) between the inlet substrate ($X_{Substrate}$) and the outlet digestate ($X_{Digestate}$) was calculated using equation 5 in accordance with mass balance approaches commonly employed in anaerobic digestion studies (Batstone et al., 2002):

$$\Delta X = \frac{X_{Substrate} - X_{Digestate}}{X_{Substrate}} \times 100 \quad (5)$$

Biogas productivity ($\dot{Y}$) was calculated based on the amount of organic matter degraded during digestion using equation 6, as recommended for evaluating the efficiency of anaerobic digestion systems (Mata-Alvarez et al., 2009):

$$\dot{Y} = \frac{V_{Biogas}}{\Delta M_{OM}} \quad (6)$$

Where V_{Biogas} is total biogas volume produced (Nm^3) (Biogas production was quantified using a low-pressure gas meter (Gurtner G2.5 N0:22200414437). Measurements were carried out daily at 10:00 a.m., and the meter was reset after each measurement. At the end of the digestion period (32 days), the cumulative daily biogas volumes were summed to determine the total biogas production), and ΔM_{OM} is the mass of degraded organic matter (kg).

Statistical analysis of data was carried out using R software, version 4.5.1 (2025). T-Student’s test was used to determine whether there was a significant difference between the manure and sludge used, as well as between the substrate and resulting digestate. The null hypothesis “H0: there is no significant difference between the mean of the two variables” is rejected if the p-value is less than 0.05.

3 Results and discussion

3.1 Physicochemical composition of the co-substrates

Figure 2 presents the mass composition of chicken manure and banana fiber extraction sludge. Chicken manure exhibited a high dry matter content (85.8 ± 0.93%) and a significant proportion of organic matter (61.82 ± 0.60%), while banana fiber extraction sludge was characterized by a high moisture content (95.37 ± 0.78%) and a high C/N ratio (104.90 ± 4.61).

These two substrates are significantly different (Table 1), and the parameters in which they differ most are water content (%H_2O), dry matter content (%DM), organic matter content (%OM) and the C/N ratio.

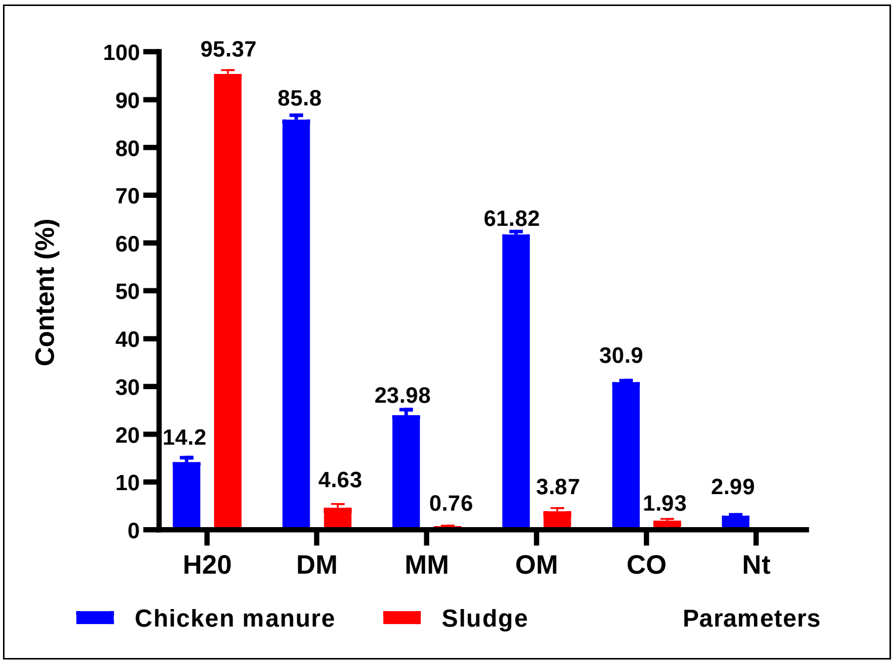

Figure 2. Mass composition of the co-substrates.

Table 1. Results of comparative tests (Fisher (LSD)) between chicken manure and sludge.

Comparison	Parameter	Mean value 1	Mean value 2	Difference	p-value	Significance
Chicken manure (1) vs Sludge (2)	H_2O	14.2	95.367	-81.167	1.554e-07	***
	DM	85.8	4.633	81.167	1.554e-07	***
	MM	23.98	0.763	23.217	0.00172	**
	OM	61.82	3.87	57.95	1.838e-07	***
	Nt	2.987	0.018	2.968	0.00214	**
	C/N	10.395	104.902	-94.507	0.00134	**

3.2 Anaerobic co-digestion implemented

Figure 3 illustrates the experimental setup of co-digestion and products.

The equivalent composition of the substrate mixture, obtained from Equations 1 and 2, is presented in table 2. The mixture exhibited a dry matter content of 23.77 ± 0.39% and an organic matter content of 17.39 ± 0.24%, corresponding to a dry anaerobic digestion process. The calculated C/N ratio of the mixture was 11.51 ± 0.34 and the organic loading rate applied to the digester was 0.155 ± 0.002 t OM/m^3.

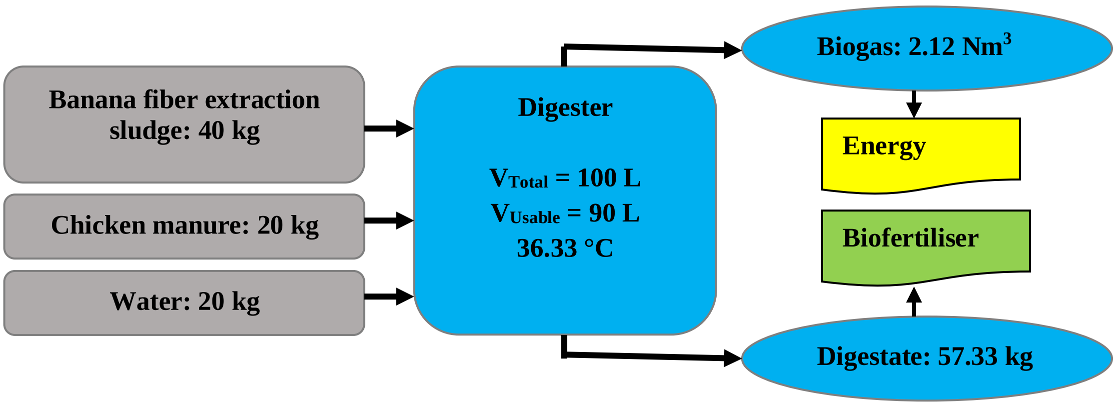

Figure 3. Experimental setup of waste recovery processes and products obtained.

Table 2. Composition of the substrate introduced into the digester.

Parameter	Equation	H_2O	DM	MM	OM	CO	Nt
$\dot{P}$ (%)	1	76.23 ± 0.39	23.77 ± 0.39	6.38 ± 0.29	17.39 ± 0.24	8.69 ± 0.12	0.76 ± 0.05
$\dot{M}$ (kg)	2	60.99 ± 0.32	19.01 ± 0.32	5.10 ± 0.23	13.91 ± 0.19	6.96 ± 0.10	0.61 ± 0.04

3.3 Biogaz production and composition

Figure 4 shows the cumulative biogas production (NDL) during the anaerobic co-digestion of the substrate under mesophilic conditions (Operating temperature = 36.33 ± 0.89 °C). Biogas production reached a total of 2.12 ± 0.1 Nm^3 after 31.67 ± 0.89 days of digestion.

The cumulative production curve highlights their distinct phases of anaerobic digestion: (i) an initial characterized by low biogas production (days 1-5) associated with microbial adaptation; (ii) an exponential phase marked by a rapid increase in production (days 6-15), corresponding to intense hydrolysis and methanogenesis and (iii) a plateau phase during which biogas generation gradually slowed and ceased (days 18-32).

After thirty-two days of anaerobic co-digestion, the system produced 2.12 ± 0.1 Nm^3 of biogas and 57.33 ± 2.22 kg of digestate.

The average methane concentration in the biogas was 64.65 ± 1.72% indicating a methane-rich biogas suitable for energy recovery. The daily biogas production and methane concentration content are illustrated in Figure 5.

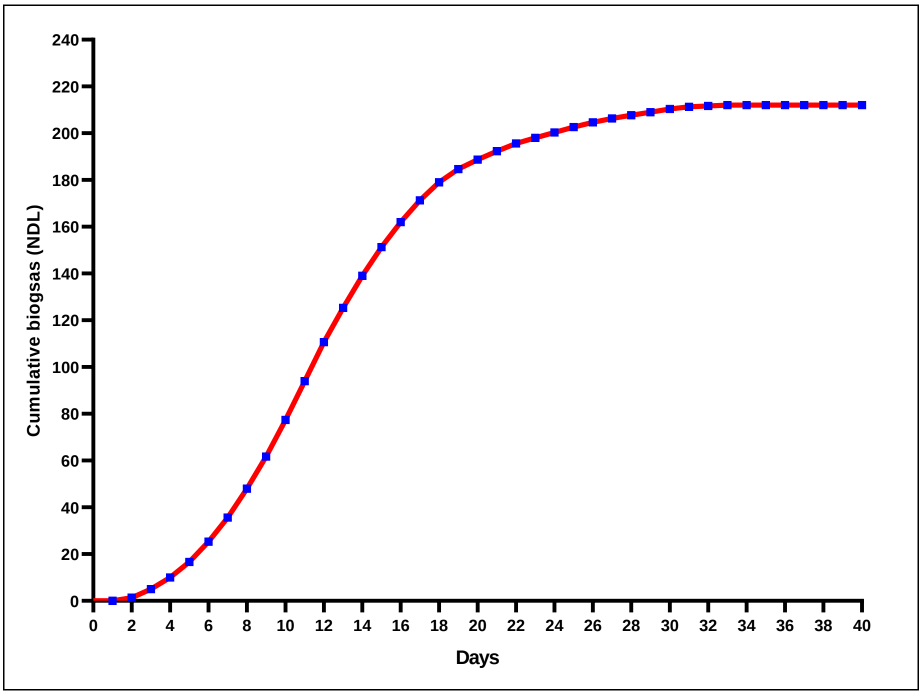

Figure 4. Cumulative biogas production (1 NDL = 0.01 Nm^3).

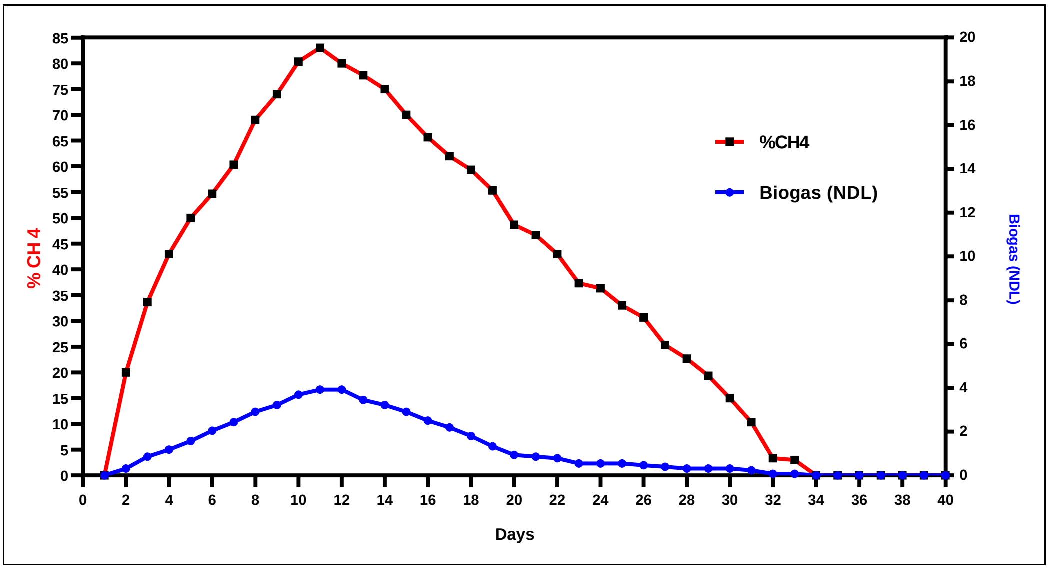

Figure 5. Daily biogas production and its methane content.

3.4 Digestate characteristics

At the end of the digestion period (31.7 ± 0.89 days), 57.33 ± 2.22 kg of digestate where covered, corresponding to 71.7 ± 2.8% of the initial substrate mass. The physicochemical composition of the digestate is summarized in Table 3, while mass variations between the inlet (substrate) and the outlet (digestate) of the digester are illustrated in figure 6. Table 4 illustrates that the composition of the digestate differs significantly from that of the substrate in terms of water content (%H_2O has increased), dry matter and, in particular, organic matter (%MM and %MO have decreased).

The biogas productivity of the system reached 188 ± 9 Nm³/t OM, 163 ± 4.7 Nm³/t DM, 94.3 ± 7.5 Nm³/t Substrate, or 23.5 ± 1.1 Nm³/m³ Digester.

Table 3. Composition of the digestate.

Parameter	H_2O	DM	MM	OM	CO	Nt
Ṗ (%)	89.45 ± 0.66	10.55 ± 0.66	6.00 ± 1.00	4.55 ± 0.92	2.27 ± 0.46	1.00 ± 0.14
Ṁ (kg)	51.28 ± 1.67	6.06 ± 0.55	3.43 ± 0.58	2.63 ± 0.62	1.31 ± 0.31	0.57 ± 0.06

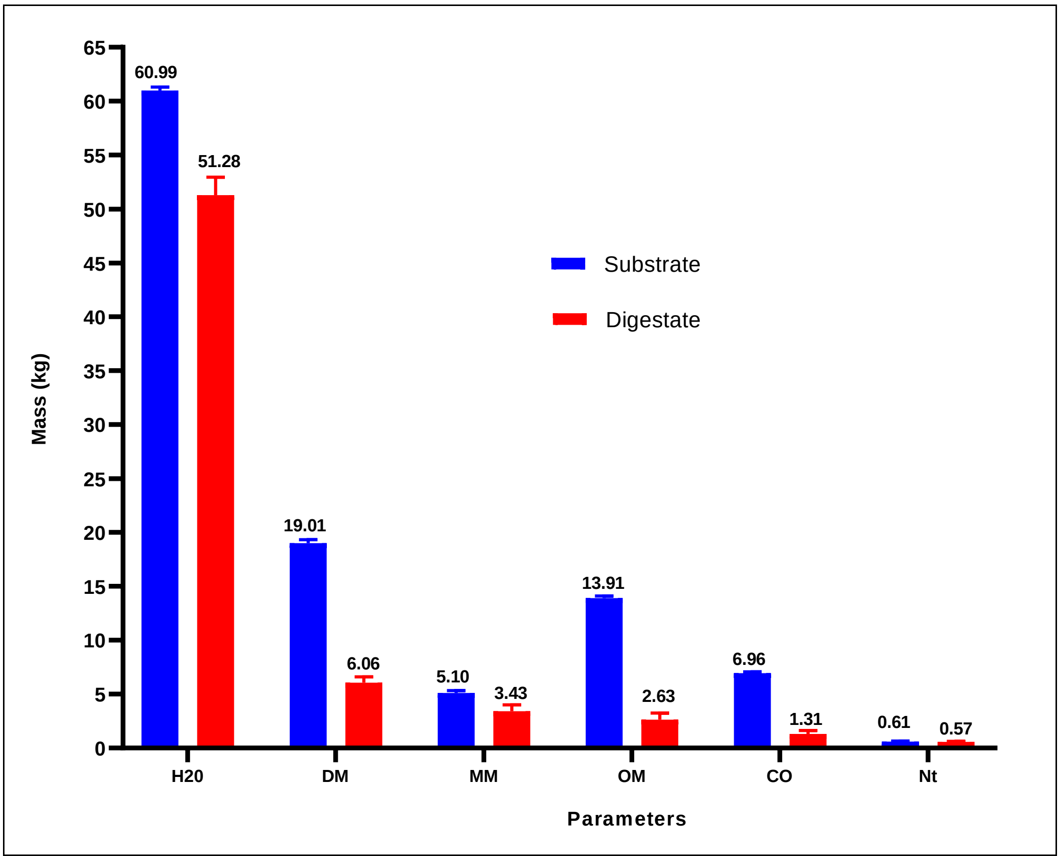

Figure 6. Mass variation between the substrate and the digestate.

Table 4. Results of comparative tests (T-Student) between substrate and digestate.

Comparison	Parameter	Mean value 3	Mean value 4	Difference	p-value	Significance
Substrate (3) vs Digestate (4)	H_2O	76.233	89.453	-13.22	0.00015	***
	DM	23.767	10.547	13.22	0.00015	***
	MM	6.377	6.0	0.377	0.70214	Non-significant
	OM	17.39	4.547	12.843	0.00184	**
	Nt	0.758	1.003	-0.245	0.14238	Non-significant
	C/N	11.511	2.369	9.142	0.00026	***

4 Discussion

The chicken manure used in this study exhibited a high dry matter content (DM = 85.8 ± 0.93%) and was rich in organic matter and Nitrogen (OM = 61.82 ± 0.60% or 72% DM; Nt = 2.99 ± 0.18%; C/N = 10.40 ± 0.62). Indeed, the dry matter content of this manure was higher than the average value of 58.6% reported by Levasseur et al. (2022) for poultry manure after analyzing 56 chicken manure samples. This higher dry matter content can be attributed to the prolonged storage period of approximately 30 days between the end of the batch process and sample collection for analysis. However, the organic matter and nitrogen contents were similar (72% DM and 2.99% Nt) to those reported by Levasseur et al. (2022) confirming the high methanogenic potential of this substrate, as also emphasized by Linas et al. (2020).

The banana fiber extraction sludge was highly liquid (%DM = 4.63 < 10), rich in organic matter (83.5% DM), and strongly carbonaceous (C/N = 104.9 > 30). These results are very close to those reported by Sango et al. (2011) who observed an organic matter content of 80.57% in the dry fraction of the banana stem, as well as with the results of Kamdem et al. (2011) and Ngahane et al. (2026), who reported an ash content of approximately 19.43% DM in banana tree waste, a high C/N ratio close to 100, and a moisture content of 91% in the banana pseudo-stems. The slight discrepancies observed can be attributed to the reduction of the solid fraction during the fiber

extraction process. The different nature of these two substrates is reflected in their contrasting physicochemical properties, particularly with respect to moisture content, organic matter concentration, and carbon-to-nitrogen. (Ward et al., 2008; Mata-Alvarez et al., 2009). Overall, these results confirm the complementarity of nitrogen-rich chicken manure and carbon-rich fiber extraction sludge, supporting their suitability for anaerobic co-digestion.
The anaerobic digestion process was operated under high organic loading (154.6 ± 2.1 kg OM/m^3), dry conditions (DM = 23.77 ± 0.39%), and mesophilic temperature (36.33 ± 0.89 °C), with a hydraulic retention time of 31.67 ± 0.89 days. The observed biogas production phases are consistent with those reported by Sakouvogui et al. (2021) and Ngahane et al. (2026), respectively during the anaerobic and mesophilic co-digestion of pig slurry and cow dung for 25 days and during the anaerobic and mesophilic co-digestion of banana pseudo-stem fiber extraction sludge and cow dung for 35 days. This confirms the efficient biodegradation of manure-rich organic matter under mesophilic conditions, where acetolactic methanogens typically dominate methane formation pathways (Linas et al., 2020; Batstone et al., 2002).
The biogas yield obtained in this study (188 ± 9 Nm^3/t OM, 163.5 ± 4.7 Nm^3/t DM, 94.3 ± 7.5 Nm^3/t Substrate or 23.5 ± 1.1 Nm^3/m^3 Digester; methane content of 64.65 ± 1.72%) indicates a high process efficiency and good fuel quality. This yield is significantly higher than the 21.5 Nm^3/t Substrate and 18 Nm^3/t Substrate obtained by Sakouvogui et al. (2021) and Ngahane et al. (2026), respectively. This result is likely due to the quality of the substrates (very high in nitrogen in one case and very rich in lignocellulosic biomass in the other, with very low dry matter content in both) and to the operating conditions, which did not allow for good bacterial flora activity.
Nevertheless, the biogas yield obtained in this study appears to fall within the range of experimentally reported methanogenic potentials of the individual co-substrates, namely 196.4 Nm^3/t DM for poultry manure stored for one month (ADEME, 2018), 147 Nm^3/t Substrate for poultry effluents (Blazy et al., 2024), and 24 Nm^3/t Substrate for banana pseudo-stems (Adannou et al., 2025). The observed substrate degradation kinetics and the evolution of methane concentration in the produced biogas seem to be consistent with the dry batch anaerobic digestion process implemented. In particular, methane production tended to be higher during the initial stages of digestion and gradually declined toward the end of the process, while overall biogas production decreased as readily biodegradable organic matter became depleted (ADEME, 2018). Comparable trends were reported by Douag-Tirichine et al. (2014), who observed the onset of methane production after the fifth day of digestion, with average methane concentrations of 40-45%, followed by an increase reaching up to 89% CH_4 during the anaerobic digestion of cow dung with a dry matter content of 19%.
The proportion of digestate recovered from the digester, representing 71.7 ± 2.8% of the inlet mass, as well as its compositional changes relative to the initial substrate (-81% OM, -68% DM, -33% MM, and -6% Nt), are comparable to the values reported by Ngahane et al. (2026), who observed digestate yields of approximately 76% of the inlet mass and a 67% reduction in dry matter. These results are in line with the general trend reported in the literature, according to which digestate typically accounts for 70–80% of the mass introduced into the digester, while the initial dry matter content may decrease by up to 60% during anaerobic digestion (Michau et al., 2019). The biogas production is therefore linked to the reduction in dry matter, and more specifically to that of organic matter. Given the limited reduction in mineral elements, particularly total nitrogen, the digestate appears relatively enriched in these components and therefore may be suitable for use as a biofertilizer in agricultural applications (Linas et al., 2020; CIRAD, 2000).

5 Conclusion

This study demonstrates that the anaerobic co-digestion of chicken manure and banana fiber extraction sludge, an abundant and readily available resource at the HIAFWE teaching farm in Ebolowa, is therefore a suitable and sustainable solution for the integrated and participatory management of these compatible livestock effluents and crop residues. It's a proposition of a highly effective strategy for waste valorization. The association of nitrogen-rich manure and carbonaceous banana residues creates an optimal balance for stable methanization, overcoming the limitations of mono-digestion. Under mesophilic dry batch conditions, the system achieved a high biogas yield (188 Nm^3/t OM) with a methane content of 64.65%, outperforming several recent studies on similar substrates. The process achieved an 81% reduction in organic matter while preserving essential nutrients in the digestate. This dual output provides a sustainable source of renewable energy (for heating/lighting) and biofertilizers (for crop production) at the HIAFWE teaching farm. The large-scale development of this experiment offers a robust pathway to strengthening the learners' capacity, to act for local development, ecological transition in tropical agroecosystem, to promoting decentralized energy production and integrated circular economy.

Author Contributions: Conceptualization and methodology, E.L.N., J.M.N. and S.K.L.; writing—draft and original E.L.N., J.M.N. and S.K.L.; visualization and supervision E.L.N and F.M.K.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflicts of interest.

Acknowledgments: The production of this article was made possible thanks to multiple contributions for which we would like to express our sincere gratitude. Specifically, our thanks go to Professor Philippe KOSMA, Director of the Higher Institute of Agriculture, Forestry, Water resources and Environment (HIAFWE) of the University of Ebolowa, and to Professor Paulin NANA, Head of the Agro-Environmental Analysis Laboratory (AEAL) of the HIAFWE, University of Ebolowa.

REFERENCES

[1] Adannou, A.H.; Ousman, H.; Lamine, N. 2025. Gas chromatography analysis of the methanogenic potential of lignocellulose biomass made from banana residues in Tombacounda, Sénégal. Open Journal of Applied Sciences, 15, 187-201. https://doi.org/10.4236/ojapps.2025.151013

[2] ADEME, 2018 La méthanisation en voie sèche discontinue. Guide et préconisations; ADEME: Paris, France, 66 p. https://librairie.ademe.fr/agriculture-alimentation-foret-bioeconomie/6477-la-methanisation-en-voie-seche-discontinue-guide-et-preconisations.html

[3] Angelidaki, I.; Alves, M.; Bolzonella, D.; Borzacconi, L.; Campos, J.L.; Guwy, A.J.; Van Lier, J.B. 2009. Defining the biomethane potential (BMP) of solid organic wastes and energy crops: a proposed protocol for batch assays. Water science and technology, 59(5), 927-934.

[4] APHA, 2017. Standard Methods for the Examination of Water and Wastewater, 23rd ed., American Public Health Association: Washington, DC, USA.

[5] Barbaux, A. 2023. Du biogaz fabriqué à partir de fiente de volaille. L'Usine Nouvelle, 04 Août 2023.

[6] Batstone, D.J.; Keller, J.; Angelidaki, I.; Kalyuzhnyi, S.V.; Pavlostathis, S.G.; Rozzi, A.; Vavilin, V.A. 2002. The IWA Anaerobic Digestion Model No. 1 (ADM1). Water Science and Technology, 45(10), 65–73. https://doi.org/10.2166/wst.2002.0292

[7] Blazy, V.; Galliot, P.; Gervais, F.; Levasseur, P. 2024. Mieux connaitre le potentiel méthanogène des effluents avicoles. In Journées de la Recherche Avicole et Palmipèdes à Foie Gras; Tours, France, 20–21 March 2024; 5 p. https://www.itavi.asso.fr/publications/mieux-connaitre-le-potentiel-methanogene-des-effluents-avicoles/download

[8] CIRAD, 2000. Transformation des déchets pour leur valorisation agricole; CIRAD: Montpellier, France, 14 p. https://agritrop.cirad.fr/569909/2/document_569909.pdf

[9] Douag-Tirichine, N.; Benkhelifa, A.; Bousdira, K. 2014. Biogas production from cattle manure in an arid environment: the case of N'Zab (Algeria). Renewable Energy Review, 17(3), 419-426. https://doi.org/10.54966/jreen.v17i3.445

[10] Kamdem, I.; Tomekpe, K.; Thonart, P. 2011. Production potentielle de bioéthanol, de biométhane et de pellets à partir des déchets de biomasse lignocellulosique du bananier (Musa sp.) au Cameroun. BASE, 15(3), 1-13.

[11] Levasseur, P.; Blazy, V.; Gervais, F.; Zennaro, B.; Azam, O.; Kabakian, S.; Carrere, H. 2022. Potentiel méthanogène et composition chimique des déjections porcines, avicoles, bovines, ovines et caprines. Elaboration d'une base de données. Cahiers IFIP, 8 (1), 1-8.

[12] Linas, J.; Alvyra, S.; Jonas, V.; Kristina, A-V. 2020. Biogas production from chicken manure at different organic loading rates in a mesophilic full-scale anaerobic digestion plant. Biomass and bioenergy, 141, https://doi.org/10.1016/j.biombioe.2020.105693

[13] Mata-Alvarez, J.; Dosta, J.; Romero-Güiza, M.S.; Fonoll, X.; Peces, M.; Astals, S. 2014. A critical review on anaerobic co-digestion achievements between 2010 and 2013. Renewable and Sustainable Energy Reviews, 36, 412–427.

[14] Michau, J.; Laurent, Q.; Jordan-Meille, L.; Salducci, X.; Morel, C.; Nesme, T.; Plat, B. 2019. Comment modéliser le développement d'un système innovant de méthanisation collective et à hautes performances environnementales à l'échelle d'un micro-territoire. Innovations Agronomiques, 71, 275-293. https://hal.science/hal-02185872/document

[15] Ngahane, E.L.; Tchiofo, L.R.; Mbakop, K.F. 2026. Material balance of an experimental banana pseudo-stems valorization plant (Ebolowa-Cameroon). Revue Internationale du Chercheur, Vol. 7, n° 2, pp 958-977. https://doi.org/10.5281/zenodo.20650455

[16] Pountounynyi, P.; Kenfack, L.S.; Chelem, M.; Chara-Dackou, V.S.; Mounkang, O.; Vondou, D.A. 2025. Potential assessment of biomethane fuel production from municipal sewage plant sludge: Kinetic modeling studies and Techno-economic analysis, Processes, 27, 106312.

[17] Sakouvogui, A.; Kamano, M.; Bangoura, M.; Keita, M. 2021. Production du biogaz à partir du lisier de porc et de la bouse de vache en mono et en co-digestion à l'Université de N'zérékoré, République de Guinée. Revue Ivoirienne des Sciences et Technologies, 38, 281 – 295. http://www.revist.ci

[18] Sango, Thomas. 2016. Valorisation des sous-constituants de pseudo-troncs de bananier dans des matériaux biopolymères. Master Thesis, Université de Lille, 154 p. https://pepite-depot.univ-lille.fr/LIBRE/HDR/2016/DSR2016LIL134.pdf

[19] Soheil, A.N.; Maedeh, M.; Ghasem, D.N.; Pooya, L. 2017. Anaerobic co-digestion of animal manures and lignocellulosic residues as a potent approach for sustainable biogas production, Renewable and Sustainable Energy Reviews, 79, 308-322, https://doi.org/10.1016/j.rser.2017.05.137

[20] Tawfik, A.; Eraky, M.; Osman, A.I.; Ai, P.; Zhou, Z.; Meng, F.; Rooney, D.W. 2023. Bioenergy production from chicken manure: a review. Environmental Chemistry Letters, 21, 2707–2727. https://doi.org/10.1007/s10311-023-01618-x

[21] Ward, A.J.; Hobbs, P.J.; Holliman, P.J.; Jones, D.L. 2008. Optimization of the anaerobic digestion of agricultural resources. Bioresource Technology, 99(17), 7928–7940.