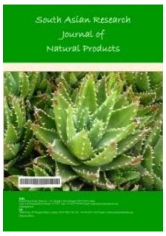

South Asian Research Journal of Natural Products

2(3): 152-156, 2019; Article no.SARJNP.52887

Influence of Retention Time on the Optimization of Biogas Production from Water Hyacinth and Cow Dung Blend

N. A. Osaribie[1], O. Ewa[2*], M. R. Karimah[3] and Ayuba Victoria[4]

[1]Department of Chemical Engineering, Niger Delta University Wilberforce Island, Bayelsa State, Nigeria.
[2]Department of Medical Biochemistry, Gregory University Uturu, Nigeria.
[3]Department of Biological Sciences, Yobe State University, Damaturu, Nigeria.
[4]National Biotechnology Development Agency (NABDA) Abuja, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author NAO conceptualized the research problem, designed and executed the experimental protocols. Author OE assisted in the laboratory and managed the correspondences. Author MRK developed the manuscript. Author VA carried out the statistical analysis of the work. All authors read and approved the final manuscript.

Article Information

Editor(s):
(1) Dr. Prasong Srihanam, Professor, Department of Chemistry, Faculty of Science, Mahasarakham University, Thailand.
Reviewers:
(1) Nikiema Mahamadi, University of Fada N'Gourma, Burkina Faso.
(2) Moutaz Benali, Omar Al-Mukhtar University, Libya.
Complete Peer review History: http://www.sdiarticle4.com/review-history/52887

Original Research Article

Received 20 September 2019
Accepted 25 November 2019
Published 17 December 2019

ABSTRACT

The aim of this study was to evaluate the influence of retention time on the production of biogas from a blend of cow dung and water hyacinth. The study was designed to include three production trials. These were the Cow dung Production Trial (CPT), Water Hyacinth Production Trial (WPT) and Cow dung-Water hyacinth Production Trial (CWPT). For the CPT, 0.5 kg of cow dung was dissolved in 7 litres of water to form slurry which was sieved before being introduced into the digester alone, while for the WPT, chopped water hyacinth was introduced into the digester alone and for the CWPT, cow dung slurry alongside chopped water hyacinth was introduced into the digester. The three production trials were performed at the temperature of 35ºC and pH of 6.8 and lasted for 40 days in ranges of 0-10, 11-20, 21-30 and 31-40. Results obtained from the study showed a uniform trend in the production of biogas for the three different production trials. Highest level of biogas production was recorded at day 11-21 thus, CPT (53.7 ml), WPT (35.67 ml) and CWBPT (89.37 ml). This was followed the values recorded on day 31-40 as follows; CPT (38.1 ml),

**Corresponding author: Email: ewahalfred@gmail.com;*

WPT (22.1 ml) and CWBPT (60.02 ml). However, this was elevated compared to the values obtained for day 0-10. In conclusion, this study has established that biogas production from cow dung, water hyacinth as well as their combination is most efficiently achieved between 11th-21st day of production.

Keywords: Biogas; cow dung; water hyacinth; digester; production.

1. INTRODUCTION

The indispensability of electricity is justified by the staggering economy that characterises Nigeria and other developing countries with unstable electric power supply. Electricity is a multitalented energy currency' that underpins a wide range of products and services that improve the quality of life, increase workers productivity and encourage entrepreneurial activity. This makes electricity consumption to be positively and highly correlated with real per capita GDP [1]. Thus, access to modern energy has undoubtedly been identified as a strategic pathway towards achieving sustainable economic development [2]. This is evident by its stimulatory effects on other sectors of a nation's economy such as health, education, agriculture, commerce and transportation etc and as a consequence, culminates to a robust standard of living of the citizens [3]. Nigeria, despite being the largest economy in the sub-Saharan Africa is known with obvious limitations in the power sector as its potential to generate 12,522 megawatts (MW) of electricity has been relegated to just about 4,000 MW rationed among the ever increasing population of the country [4]. Although several strategic efforts have been made by the Federal government to stabilize power supply in Nigeria, the pertinence of the failure of these efforts cannot be denied. Thus, the economic prosperity of the country is left at the mercy of alternative sources of electricity.

Fossil fuel is a renowned source of energy for the ever increasing world population. It consists of oil, coal and natural gases. Fossil fuels contribute about 85% the global energy consumption with Nigeria being its largest consumer [5]. It is the major source of carbon emission globally especially in Nigeria where climate changes and its attendant consequences is conspicuously noticed in the ecosystem [5]. Achieving solutions to possible shortage in fossil fuel and environmental problems that have bedeviled the world require a long-term potential action for sustainable development. In view of this, renewable energy resources appear to be one of the most efficient and effective solutions to this problem [6]. Biogas is a colourless, flammable gas which is produced via anaerobic digestion of animal, plant, human, industrial and municipal wastes among others and constitutes of methane (50-70%), Co_2 (20-40%) and traces of other gases such as nitrogen, hydrogen, ammonia, hydrogen sulphide and water vapour Maishanu [7]. Its production is purely a microbial process and as such depends entirely on microbial activities which are driven by time and phases of microbial growth.

Water hyacinth (*Eichhornia crassipes*), a monocotyledonous fresh water aquatic plant and a member of the family of pontederiaceae was developed throughout the world in the late 19th and 20th century [8]. This important plant has been used extensively in the treatment of wastewater as well as in the remediation of heavy metal and dye. In addition, it has been employed in the production of bioethanol and biogas owing to its exuberance and high carbon nitrogen ratio of 15 [9]. Cow dung as the name implies is feces of cattle. It is rich in native microbial flora that aid in rapid biogas production. It has been scientifically established that cow dung is a proficient starter for poor producing feed stock and thus has been the basis for numerous cow dung driven blends [10].

Although research findings have indicated that the synergistic interaction of water hyacinth and cow dung in a co-digestion process as an optimization effort towards biogas production is promising, the need for enhanced biogas production remains imperative in rational efforts to address excessive dependence on the fossil fuel and its attendant consequences. Thus, this work seeks to determine the influence of retention time on the proficiency of cow dung-water hyacinth blend in biogas production.

2. MATERIALS AND METHODS

2.1 Collection of Water Hyacinth and Cow Dung

Water hyacinth and cow dung were collected from the Amassoma Water Front and Amassoma Slaughter respectively in Southern Ijaw Local

Government Area of Bayelsa State, Nigeria (4°58'13" North, 6°6'35" East). The materials were transported to the Chemical Kinetics Laboratory, Niger Delta University Wilberforce Island, where their weights were determined.

2.2 Slurry Formation

To form slurry, 7 litres of water was mixed with 0.5 kg of cow dung. The slurry was subsequently sieved and introduced into a 25 litres capacity digester through the hopper with the aid of the inlet pipe. Similarly, water hyacinth was chopped and introduced along side. The opening of the digester was shut and the time at which it was fed was noted at a temperature of 35ºC and pH of 6.8.

2.3 Production and Measurement of Biogas

Biogas produced in the digester was transported to the measuring section of the gas plant via the gas pipe and valve. Water displacement method was employed to collect generated gas. This set-up was constituted of two pots of varying quality, size and weight. Two pipes emanating separately from the digester and manometer were inserted to the bottom of the larger pot. The smaller pot was placed over the two pipes inside the larger pot upside down. Water was added into the larger pot until it got to the top of the pipe. As the level of water gets to the bottom of the smaller pot, the air inside the smaller pot was expelled through the pipe with which the manometer was connected. Prior to gas production, the volumes of gas storage chamber and gas pipe lines were occupied by air. The gas produced in the gas chamber forces the air into the smaller pot of the gas measuring arrangement and the pot is uplifted. Initially the air is taken outside the pot and after sometime biogas was collected and the volume produced every 10 days was determined using the formula V=pr2h where (r is the radius of the cylindrical pot and h is the height of the pot from the water surface).

3. RESULTS

The outcome of biogas production trials are shown on Figs. 1-3.

4. DISCUSSION

Complex microbiological processes must be invoked in order achieve efficient production of biogas during which many species of microbes must be active. A distortion in the cooperative activities among these microbes reduces or halts biogas production [10] Biogas a colourless and combustible gas produced by the biological decomposition of organic biomass such as cow dung, green waste and agricultural residue such as cassava, sugar cane etc is a mixture of different gases, mainly methane (CH4) among others. Its high methane content makes it an attractive source of energy Umeghalu et al. [11]. Being a microbial process, its production is significantly associated with phases of microbial growth which in turn is driven by time.

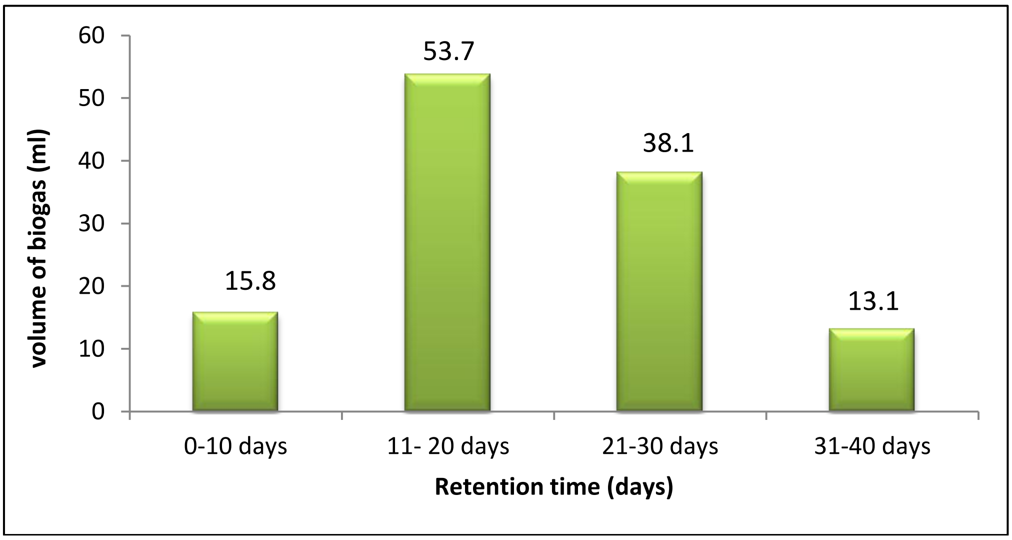

Fig. 1. Production of biogas from water cow dung alone

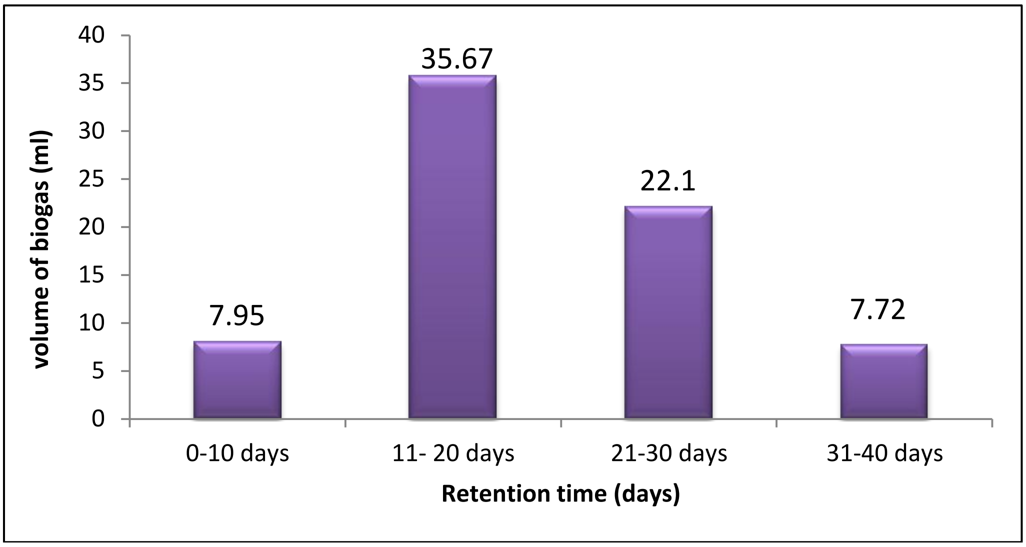

Fig. 2. Production of biogas from water hyacinth alone

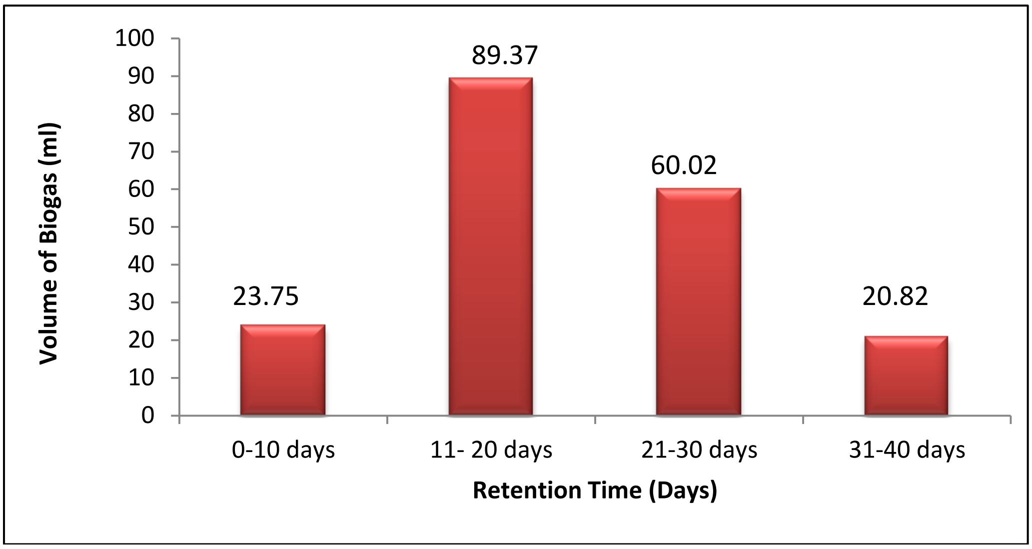

Fig. 3. Production of biogas from cow dung, water hyacinth blend

Figs. 1-3 show the production of biogas from cow dung, water hyacinth as well as the combination of cow dung and water hyacinth (blend) respectively. A uniform trend of biogas production was established for the three different production trials within a 40 day trial period. However, biogas production peaked mid-way trial period ranging from day 11-20, this may be as a result of increased number of cells that characterize the exponential phase of microbial growth during biogas production process. This is evident by the fact that cells at the log or exponential phase are mostly preferred for industrial applications. This result is consistent with the work of Ezekoye et al. [12] which had established that biogas production from poultry droppings and cassava peels peaked from the first 5 days to 15 days. On the contrary, an obvious declination was recorded with the trial period ranging from 31-40 days. This may be attributed to the accumulation of toxic metabolic wastes generated from the participating microorganisms as well as nutrient exhaustion which culminates to cell death and consequently a reduced synthesis of methane among other by-products. This finding is consistent with the finding of Ezekoye et al. [12] which had established that the yield of biogas generated from poultry droppings and cassava peels declined after 30 days.

5. CONCLUSION

Findings made from this work show that elongated period of digestion is counterproductive evident by the declination of biogas production observed at the extreme of retention time with the production periods studied in this work. Therefore, efforts to produce biogas from raw materials such as cow dung, water hyacinth or their combination should not be extended beyond the observed productive limit so as to minimize wastage of resources in an effort to maximize biogas production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Philip KA. Electricity consumption-economic growth nexus: The ghanaian case. IJEEP. 2011;(1)1:18-31.
2. Sulaimon AY. Energy sector is critical to Nigeria growth and development: Perspective to electricity sub-sector in Nigeria. MPRA Paper No. 55689; 2014.
3. Wolde R. Energy demand and economic growth: African experience. J Policy Modeling. 2005;27:89–903.
4. Adekomaya O, Adama K, Okubanjo A. Bridging environmental impact of fossil fuel energy: The contributing role of alternative energy. JESR. 2018;23(2):22-27.
5. Kaygusuz K. Türker MF. Biomass energy potential in Turkey, Renewable Energy, Elsevier. 2002;26(4):661-67825.
6. Maishanu SM, Musa M, Sambo AS. Biogas technology: The output of the Sokoto energy research centre. Niger. J. Solar Energy. 1990;9(1):83-194.
7. Wilson JR, Holst N, Rees M. Determinants and patterns of population growth in water hyacinth. Aqua. Bot. 2005;81:51-67.
8. Patel S. Threats, management and envisaged utilizations of aquatic weed *Eichhornia crassipes*: An overview. Rev. Environ. Sci. Biotechnol.2012;11:249-259.
9. Yadvika TS, Kohl RS, Rana V. Bioresour Technol. 2004;95:1-10.
10. Anna S, Åsa J. Microbiological handbook for biogas plants. Swedish Waste Management. U2009:03 Swedish Gas Centre Report 207; 2009.
11. Ezekoye VA, Ezekoye BA, Offor PO. Effect of retention time on biogas production from poultry droppings and cassava peels. Nig J. Biotech. 2011;22:53-59.
12. Umeghalu C, Chukwuma E, Okonkwo I, Umeh S. Potentials for biogas production in Anambra State of Nigeria using cow dung and poultry droppings. IJVS. 2012;1: 26-30.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/52887