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Investigation into the Suitability of Talinum Triangulare (Water Leaf) as a Seeding Agent for Domestic Wastes in Nigeria

P.O. Ebunilo[a], I.B. Owunna[a], E.G. Sadgere[a], S.I. Ukwagba[b], E.K.Orhorhoro[c]*

[a]Department of Mechanical Engineering, University of Benin, Benin City, Edo State, Nigeria
[b]Petroleum Training Institute, Effurun, Delta State, Nigeria
[c]Cemek Machinery Company, Technology Incubation Centre, Federal Ministry of Science & Technology, Benin City, Edo State, Nigeria

*Corresponding author. Tel.: +2348064699781;
E-mail address: kelecom@yahoo.com

A b s t r a c t

An investigation into the suitability of talinum triangulare (water leaf) as a seeding agent for domestic waste was conducted. During the investigation, two different compositions of organic domestic waste substrates were used via: domestic wastes only and domestic wastes seeded with talinum triangulare. The domestic wastes comprised of yam peelings, plantain peelings, left over of garri, rice, beans and oil. The experiments were conducted over a period of thirty-five days for each composition of domestic wastes. Domestic wastes seeded with talinum triangulare started producing earlier, had shorter period between evacuations and production ended distinctly when compared to composition of domestic wastes only..

Keywords:

Domestic wastes,
Talinum triangulare,
Seeding agents,
Steel Bio-digester,
Nigeria.

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1. Introduction

The demand for energy in Nigeria is growing by the day. Nigeria has a human population that is over 160 million [1]. There is a need for alternative energy sources that are adequate and within the reach of average Nigerians. Currently, about 70% of the total population in Nigeria live and depend almost on fuel wood [2]. They use firewood; kerosene and charcoal to supply energy in households and this have negative effect on human health and the environment ([3]; [4]). Cooking with fossil fuels and wood fuel lead to deforestation, soil erosion, loss of habitat for flora and fauna, emission of unwanted gases into our environments and this is believed to have affected the ozone layer thereby causing greenhouse effect which may lead to global warming [5]. The biogas technology uses biomass to produce energy and this can help in reducing the use of fossil fuels and firewood in Nigeria. The process reduces greenhouse gas emissions, pollutions and improves wastes

management ([6]; [7]; [8]). Biogas is a clean gas that can, in principle, be used like other fuels gases like butane for households and industrial purposes. Biomass represents a continuously renewable potential source of biogas and thus offers a partial solution to the eventual prospects of fossil fuels depletion. In addition, biomass can be economically converted to biogas at a variety of scales and thus can be tailored to supply local, regional and nationwide biogas needs [9].

Biogas seeding is the addition of the slurry containing microbes to the freshly prepared slurry. It has been shown that after feeding the digester with freshly prepared slurry, it takes some days before it starts producing gas. But when seeded, gas production starts immediately [10].

Talinum triangulare (water leaf) is a cosmopolitan weed throughout the humid tropics. It grows throughout the seasons especially during the rainy season in Nigeria. Talinum triangulare (water leaf) contains per 100g edible portion: water 90.8g, energy 105kJ (25 kcal), protein 2.4g, fat 0.4g, carbohydrate 4.4g, fiber 1.0g, calcium (Ca) 121mg, phosphorous (P) 67mg, Iron (Fe) 5.0mg, thiamin 0.08mg, riboflavin 0.18mg, niacin 0.3mg, ascorbic acid 31mg [11].

Despite Nigeria huge biogas potential, energy for domestic and commercial use is still a major problem. Anaerobic digestion of domestic wastes is prolong in the absent of seeding agent and the available seeding agent at present in Nigeria is cow dung which is not readily available like talinum triangulare (water leaf). This research work is aim at the investigation into the suitability of talinum triangulare (water leaf) as a seeding agent for domestic wastes in Nigeria.

2. Experimental procedures

2.1 Materials

The materials used were: Domestic wastes, talinum triangulare, steel bio-digester, thermometer, a plastic bucket, connectors and hose, gas cylinder, manometer and weighing balance. The weighing balance was used to measure the weight of domestic wastes, talinum triangulare and the quantity of biogas collected at each evacuation. Thermometer and manometer were used to measure temperature readings and pressure readings respectively. The steel bio-digester measuring 140mm x 395mm x 5mm was used to digest the substrates.

2.2 Experimental test

Domestic wastes comprising of: rice, garri, beans, plantain, yam and talinum triangulare were cut into pieces with sharp kitchen knife to increase its surface area and the mixed with water in a ratio of one to two. The mixture was charged into the bio-digester and made air tight. The digester content was stirred several times per day with the aim of mixing the substrates inside the digester for efficient biogas generation. Digestion was allowed to take place under the same environmental condition. The manometer was used to monitor biogas production and thermometer to monitor temperature reading of sample 1 (domestic wastes only) and sample 2 (domestic wastes and talinum triangulare) as shown in Table 1 and Table 2 respectively. A flame test was carried out; yellow flame indicates gas production but that does not really mean proper methane production had started. Blue flame confirms proper methane production. The biogas produced was properly purified and evacuated into 7.5kg gas bottle for home use.

Table 1: Experimental test result with sample 1

DOMESTIC WASTES ONLY				
S/N	**Temp (0C)**	**P_G**	**$P_{(mmH20)}$**	**Remark**
1	28	-	-	No gas
2	30	-	-	No gas
3	25	-	-2.5	No gas
4	33	-	-1.6	No gas
5	30	-	-0.02	No gas
6	34	-	-	No gas
7	35	-	-	No gas
8	33	-	-	No gas
9	32	-	-	No gas
10	32	-	-	No gas
11	29	-	-	No gas
12	33	-	-	No gas
13	35	12	-	Yellow flame
14	29	20	-	Yellow flame
15	33	28	-	Yellow flame
16	34	30	-	Blue flame
17	32	35	-	Blue flame
18	34	48	-	Blue flame
19	**Evacuation to storage takes place**			
20	24	20	-	Blue flame
21	31	27	-	Blue flame
22	24	28	-	Blue flame
23	36	30	-	Blue flame
24	35	40	-	Blue flame
25	**Evacuation to storage takes place**			
26	32	25	-	Blue flame
27	34	30	-	Blue flame
28	33	36	-	Blue flame
29	**Evacuation to storage takes place**			
30	34	28	-	Blue flame
31	35	25	-	Blue flame
32	34	20	-	Blue flame
33	35	15	-	Blue flame
34	33	15	-	Blue flame
35	**Evacuation to storage takes place**			

Table 2: Experimental test result with sample 2

DOMESTIC WASTES + TALINUM TRIANGULARE				
S/N	**Temp (0C)**	**P_G**	**$P_{(mmH20)}$**	**Remark**
1	28	-		No gas
2	30	-		No gas
3	25	-		No gas
4	33	-		No gas
5	30	15		Yellow flame
6	34	18		Blue flame
7	35	35		Blue flame
8	33	50		Blue flame
9	**Evacuation to storage takes place**			
10	32	25		Blue flame
11	29	40		Blue flame
12	33	50		Blue flame
13	35	48		Blue flame
14	**Evacuation to storage takes place**			
15	33	25		Blue flame
16	34	30		Blue flame
17	32	45		Blue flame
18	34	50		Blue flame
19	32	49		Blue flame
20	**Evacuation to storage takes place**			
21	31	28	-	Blue flame
22	24	35	-	Blue flame
23	36	38	-	Blue flame
24	**Evacuation to storage takes place**			
25	36	43	-	Blue flame
26	32	38	-	Blue flame
27	**Evacuation to storage takes place**			
28	33	20	-	Blue flame
29	31	15	-	Blue flame
30	34	10	-	Blue flame
31	**Evacuation to storage takes place**			

3. Results and discussion

From Table 2 domestic wastes seeded with talinum triangulare (water leaf) yield earlier (day 5) and stop yielding on time (day 30) when compared to the composition of domestic wastes not seeded with talinum triangulare (water leaf) that started yielding on day 13 and stop yielding on day 34 (Table 2.2). The quick yielding of domestic wastes with talinum triangulare shows that talinum triangullare enhances quick anaerobic digestion of the domestic wastes unlike the domestic wastes without talinum triangulare. The high water content of talinum triangulare (81.9%) enhances the hydrolysis process which is the first stage of anaerobic digestion of the domestic wastes before the other two stages (fermentation and methanogenesis). During hydrolysis, long-chain molecules such as protein,

carbohydrate and fat polymers are broken down to smaller molecules called monomers [12].

Table 3: Comparison of frequency of evacuation

DAYS OF EVACUATION	
SAMPLE 1	**SAMPLE 2**
19	9
5	4
3	5
5	3
-	2
-	3

Table 3 shows the frequency of evacuation of the unseeded composition of domestic wastes (Sample 1) and seeded domestic wastes with talinum triangulare (Sample 2). Evacuation was more frequent with seeded composition of domestic wastes when compared to the unseeded composition of domestic wastes. The frequency of evacuations in the seeded composition of domestic wastes shows that digestion was faster than the unseeded composition of domestic wastes. It will be observed from Table 2.2 that biogas production ended first with the seeded domestic wastes unlike the unseeded domestic wastes and this has to do with the fact that with seeding agent (talinum triangulare), digestion was faster. The faster the digestion the shorter the period of production and once digestion is complete, biogas production eventually stop [9]. For sample 1 which is not seeded, digestion was expected to be slow hence the longer time of production.

4. Conclusion

As indicated in Table 2.2, it took shorter time for composition of seeded domestic wastes with talinum triangulare (water leaf) to start yielding of biogas when compared to the unseeded composition of domestic wastes (Table 2.1). Therefore, this suggests that talinum triangulare (water leaf) can be used as a seeding agent for biogas production. The availability of talinum triangulare in Nigeria makes it more suitable when compared to other existing seeding agents like cow dung which is not available in large quantities.

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