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STUDIES ON THE BIOMTHENOGENIC POTENTIAL OF SOME ORNAMENTAL PLANTS

H. V. DESHMUKH*
Department of Microbiology, Yashawantrao Chavan Institute of Science, Satara - 415 001, Maharashtra, INDIA
e-mail:deshmukhhv@gmail.com

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***Corresponding author**

ABSTRACT
Overdependence on fossil fuels leads to severe energy crisis. To overcome this energy crisis we have to give extra emphasis on indigenous and renewable energy sources. The present paper includes the study of energy production mainly biogas from commonly occurring ornamental plants. Experiments were carried out in 1-L digester flasks in the batch process up to seven weeks; there was a marked increase in biogas production after pretreatment of plants. Measurement of biogas was done by water displacement method and analysis of biogas by GLC. *Peltophorum pterocarpum, Lantana camera* and *Bonginvillea spectabilis* showed 14.60, 13.40 and 12.20L/100gm biogas production respectively, while control shows 10.60 L /100gm biogas. The use of these plants can be made to supplement the conventional substrate like dung in urban and rural areas to augment the biogas production.

INTRODUCTION

The biogas production technology even today by and large caters to the need of rich farmers only because to meet daily biogas need of a family of four persons on an average 25kg/ day of dung will be required and hence in order to augment the resource for biogas generation tapping of other substrates has become necessity to supplement gas production. Though, any kind of biomass can serve as substrate, the technology is primarily based on cow dung or farm yard manure, for over seventy five years.

A large number of publications have appeared to test the potentiality of other forms of biomass. Animal excreta like camel, house pig and poultry has been compared with that of cow dung (Malik *et al*., 1990; Biswas, 1997). Agricultural wastes like Barley straw (Lim *et al*., 1986); Cotton plant stalks (El-Shinawi *et al*., 1989); rice straw (Dhar and Tandon, 1987) and tomato plants (Trujillo *et al*., 1993) have been tested. In most of the cases pretreatment in the form of soaking in water, acid or alkali was found to increase the biogas content on digestion mixed with cow dung or any other animal waste.

In recent years target of biogas technology has shifted from energy recovery to environmental protection. This development is demonstrated in developed countries such as Denmark and Netherland, which have intensive agricultural production including agro industries.

Some entire weeds, silage crops and foliage of variety of trees have also been employed mainly as additive to cow dung to improve the quality and quantity to biogas. In the present work similar attempt to test biomethanation potential of different ornamental plants has been evaluated. The main aim of this study was to identify most promising ornamental plant as additives to supplement cow dung run biogas

MATERIALS AND METHODS

Plants

1) Ornamental Plants: Different ornamental plants were collected from Vashi, Navi Mumbai area (India). Each plant used for biogas production was studied botanically, its identification ascertained and herbarium specimens were prepared. These have been labeled and preserved.

(A) *Peltophorum pterocarpum* **-** It is a common ornamental avenue tree found along roads and public gardens. It has dense foliage with large compound leaves. It is an evergreen tree of family Caesalpineae.

B) *Cassia renigera* - It is an ornamental, avenue evergreen tree commonly found along the road sides. It has large compound leaves; with dense green foliage. It belongs to family Caesalpineae.

C) *Lantana sp.* - It is perennial shrub found at roadsides, wastelands and in the degraded forests. It grows densely forming thickets on forest floors. It has highly glandular, strongly scented leaves. It is an evergreen species belonging to family Verbenaceae.

D) *Bougainvillea spectabilis* - This is an ornamental plant found in public gardens and private houses; it has green hairy chordate leaves. It is an evergreen plant belonging to family Nyctaginaceae.

2) Digesters: 1-L capacity flasks,

3) Cow dung and gober gas slurry

4) Gas measurement assembly,

5) Combustibility testing assembly,

6) GLC.

Collection of samples: Leaves and twigs of different plants were mainly selected to test their efficacy for methanogenesis. The plant material was chopped and cut into the pieces of about 2cm and air dried for 24 hours at room temperature (32-34ºC) before further processing.

Pretreatment (Alkali hydrolysis): The 25g of the air dried plant samples were treated with 1% NaOH solution for 8 days using ten parts of alkali solution to one part of the substrate *i.e.,* 25g of plant samples in 250mL 1%NaOH solution at room temperature (32-34ºC).

Batch process: Experiments were conducted in batch digesters made by round bottom flasks of l-L capacity. Residue of cow dung based gas digester was used as inoculums. It was the source of methanogenes. Slurry for the digesters was prepared as follows.

Preparation of slurry: a. Control samples – 50 g fresh cow dung plus 50g freshly collected inoculums.

b. Test samples **–** 25g fresh cow dung plus 25g unhydrolyzed/ hydrolyzed plant residue plus 50mL freshly collected inoculums. The pH of the final slurry was adjusted to 7 using digital pH meter by adding 0.1N HCL solution before transferring to digesters.

Slurries of the different plant samples were transferred to different mini digesters. Total volume in digester was adjusted to 650mL using tap water. The digesters flasks were sealed with rubber cork, made air tight with plaster of Paris and connected to inverted calibrated saline water bottle filled with water, with the help of an IV set for gas measurement. The digestion process continued up to 7 weeks. The digesters were vigorously agitated once daily.

Measurement of gas: Biogas, which was produced in digesters, proportionately displaced water level for which saline bottle was provided an outlet. After complete displacement of water from the bottle, it was tested for the combustibility test and reported as biogas. The new saline bottle was filled with water and connected to digester for further collection of gas.

Combustibility testing: The needle of the gas displacer was first pierced though rubber cork of the saline bottle filled with gas. The tap water was then injected into the bottle through syringe. The gas got displaced from the saline bottle and moved through the displacer which was placed in the vicinity of the burner. The production of flame indicates combustibility of the gas.

Storage of gas: The corks of the saline bottles filled with biogas were sealed with bee wax and labeled species-wise. They were stored at room temperature and used for determining the ratio of methane (CH_4) to carbon dioxide (CO_2) by gas chromatography.

Gas chromatography: The biogas produced by each plant species was analyzed for its methane and CO_2 content by using Toshiwal Gas Chromatograph at Agharkar Research Institute, Pune.

RESULTS AND DISCUSSION

From the day, the combustible gas production commenced, quantity of gas produced in each day for each set was recorded. The weekly average records of gas production are given in Table 1 and Fig. 1. Comparative account of biogas production is given in Table 2 and total biogas production are shown in Fig. 2. The percentage of CH_4 and CO_2 are shown in Fig. 3.

In Control sample the total biogas production was 10.6 L/100 g of dung in 7 weeks with 68.92 % methane. This yield was considered as standard for comparison. The biogas production was initiated in 2nd week of incubation. It was maximum in 3rd week. The gas production continued up to 7 weeks. The initial pH of the slurry was 7 and the residual slurry showed 7.6 pH.

In *Peltophorum pterocarpum* the total biogas production was 14.6 L/100g in 7 weeks with 80.75 % CH_4 and 13.62 % CO_2. This yield was more than that of the control.

Cassia renigera shows 9.30 L/100g biogas production in 7 weeks with 77.2 % CH_4 and 15.93 % CO_2. The yield was less than that of the control (10.6L/100g). The biogas production was initiated in the 3rd week of incubation. It was maximum in 5th week and continued up to 7th week. pH of residual slurry was 8.1.

Lantana camera shows 13.40 L/100g biogas production in 7 weeks with 58.3% CH_4 and 11.72% CO_2. The yield was more than that in the control but the gas showed feeble combustibility.

In *Bougainvillea spectabilis* the total biogas production was 12.2 L/100g in 7 weeks with 71.40 % CH_4 and 13 % CO_2. The yield was higher than that of the control It has been noted that

Table 1: Biogas production in mL/week/sample

Sr.No	Sample	1st	2nd	3rd	4th	5th	6th	7th	Total	L/100gm
1)	control	-	500	950	850	-	-	350	2650	10.60
2)	*Peltophorum pterocarpum*	-	-	1350	900	1000	-	200	3650	14.60
3)	*Cassia renigera*	-	-	200	550	950	250	500	2450	9.30
4)	*Lantana sp.*	-	-	-	350	1500	900	600	3350	13.40 WK
5)	*Bougainvillea spectabilis*	-	-	400	1100	450	800	300	3050	12.20

Table 2: Comparative account of biogas production by different plant species

Sr.No	Species	% CH_4	% CO_2	Biogas initiation week	Peak production week	Total gasProducing weeks	pH variation
1)	Control	68.92	14.50	2	3	7	7 - 7.6
2)	*Peltophorum pterocarpum*	80.75	13.62	3	3-5	5	7 – 8.2
3)	*Cassia renigera*	77.20	15.93	3	5	7	7 – 8.1
4)	*Lantana sp.*	58.30	11.72	4	5	7	7 – 8.1
5)	*Bougainvillea spectabilis*	71.48	13.00	3	4	7	7

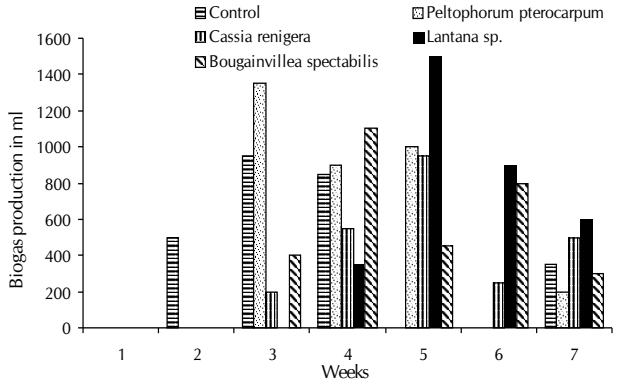

Figure 1: Biogas production in mL /week/ sample

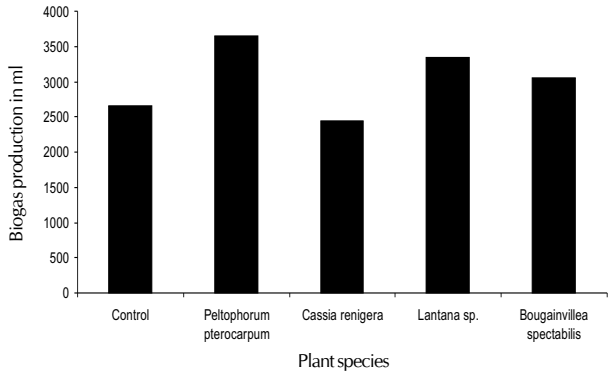

Figure 2: Total biogas production/sample

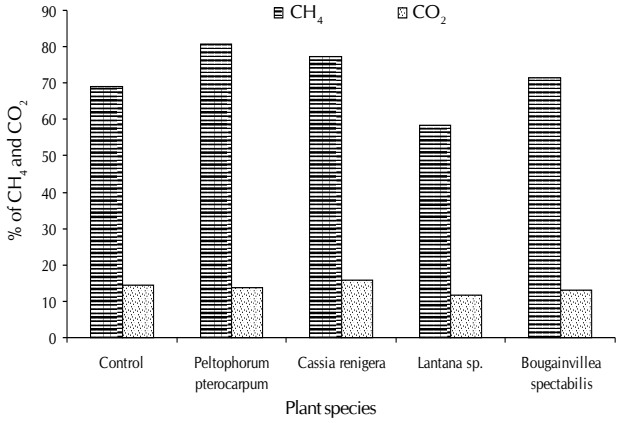

Figure 3: Percent of CH_4 and CO_2 in different plant species

unhydrolyzed plant material failed to yield the biogas, while that hydrolyzed for 7 days in 1% NaOH yielded the biogas when digested with cow dung after addition of biogas effluent as a source of methanogenes. In few cases like bagasse, soaking in water for several days was found sufficient to induce methanogenesis on anaerobic digestion, while in others acid or alkali hydrolysis was needed. Acid hydrolysis has yielded satisfactory results in few cases but in majority, alkali hydrolysis has been employed with success. Generally, one percent NaOH is employed for varying duration depending upon the nature of plant material to yield optimum results Leupold *et al*. (1993)

Most of the published reports suggest that optimum pH for biogas production varies from 6.5-7.4 Sharma *et al*. (1989). The digester slurry in the present investigation was adjusted to pH 7 prior to incubation. However, in all the cases it was noticed that the residual digester slurry has shift in pH towards alkalinity except *Bougainvillea spectabilis* where pH remains unchanged. This shift was less (7 - 7.6) in cattle dung but ranged from 8 to 8.2 in most of plant added slurries. Increase in pH of digester slurry during the period of anaerobic digestion has been noted by Nallathambi and Gunasuelan (1987) working with biogas slurry supplemented with *Parthenium*. They have shown that pH range of 8 to 8.7 is favorable for biogas production. PH change during digestion of different samples is summarized in Table 2.

In almost all the samples, combustible gas production started after some interval of initiation of digestion process. The interval varied with the samples. It was initiated in cow dung fed samples in 2nd week; 3 plant samples in 3rd week and in 1 plant sample in 4th week. In most other investigations also it was reported that initial period of digestion is not accompanied by combustible gas production. In cow dung fed digester and one plant sample, peak gas production occurred in 3rd week; in another one plant fed sample in 4th week and in two plant samples in 5th week.

Only in one sample the total biogas produced for 100g was less than that of control, while in all other plant samples higher biogas than control (cattle dung alone) with appreciably high content of methane was produced. Only *Cassia renigera* showed lower level of biogas production. Of the 4 plant samples tested, only *Lantana camera* has been investigated earlier and rest all the plants have been tested for the first time. The results with *Lantana* tally well with those of Hasan Dhar and Tondon (1987) who found it to be best amongst the plant residues tested by them.

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