Utilization of Oil Cakes for Biogenesis of Methane

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Abstract

Biogas production using non-edible oil cakes along with cattle dung was carried out. The experimental data revealed a maximum gas out put of *Arachis hypogaea* non-edible oil cake of 22815ml, followed by 20025 ml with *Pongamia pinnata* oil cake incorporated treatment along with cattle dung over a period of six weeks. The methane content ranged from 54.5 to 68 percent and the carbon dioxide content from 30 to 43.5 percent. The biodigested slurry was analyzed for their nitrogen, phosphorous, and potassium contents which revealed their usefulness as manure for possible applications in soil fertilization procedures.

Key words: Non-edible oil cake, Biogas, Methane, Carbon dioxide, total and volatile solids, manurial values

Introduction

Energy crisis has augmented research in newer thrust areas (Krishnan Vijayaraghavan *et al.,* 2006). This has resulted in finding out alternative fuels for meeting the energy demands of the developing sectors. Therefore there is a need to explore the possibility of deriving energy from various alternative sources. Cattle dung has been used so far in biogas plants for obtaining the much needed energy. The biogas production potential of non- edible oil cakes along with cow dung was investigated. The usefulness of non-edible oil cakes which are otherwise used in soap making industries was evaluated by conducting experiments in this laboratory to assess their potential for methane generation. The research revealed the maximum gas output of 22815 ml of gas output with *Arachis hypogaea* non-edible oil cake incorporated treatment, thus recording 131.5% increase over control, during a period of 6 weeks. The gas obtained burnt well indicating the presence of methane. The CO_2 content range from 30 to 43.5 %. The nitrogen, phosphorous and potassium contents of the biodigested slurry was also carried out, the results of which are discussed. The data revealed a favorable trend regarding the use of non-edible nitrogen rich oil cakes in biogas generation. Dairy manure has also been tried out as an alternative feedstock by Converse *et al.,* (1977).

Materials and Methods

Collection of Raw Materials

The various raw materials employed in this study namely cattle dung, non- edible oil cakes like *Jatropha curcas* oil cake, *Pongamia pinnata* oil cake and *Arachis hypogaea* oil cake utilized in this study were collected from various places in and around Coimbatore. Cattle dung and the oil cakes were analyzed for their physical and chemical properties such as moisture, total solids, volatile solids, nitrogen, phosphorous and potassium.

Utilization of oil cakes as various treatments for biogas generation

There were seven treatments. The details of various treatments were given as below:

T1 :	CD
T2 :	JC
T3 :	JC + 40% CD
T4 :	PP
T5 :	PP + 40 % CD
T6 :	AH
T7 :	AH + 40 % CD

CD: Cattle dung, JC: *Jatropha curcas,* PP: *Pongamia pinnata,* AH: *Arachis hypogaea*

The oil cakes were powdered and mixed with water in equal quantity (wt/wt). The cattle dung was also prepared in the same way. The seven treatments were allowed to undergo anaerobic biodigestion for a period of 6 weeks.

Cattle dung is regarded as the positive control (T1 treatment). *Jatropha curcas, Pongamia pinnata and Arachis hypogaea* oil cakes has two numbers of treatments with (T3, T5 and T7) and without cattle dung (T2, T4, and T6) respectively. Cattle dung was mixed at 40% level with the respective non-edible oil cakes treatments.

Analysis of raw materials and slurry specimens of various treatments

Physical properties like moisture content, total solids and volatile solids, chemical properties like total organic carbon, total nitrogen, phosphorous and potassium contents of raw materials as well as slurry samples of various wastes incorporated treatments were initially determined.

The biodigested slurry samples of various wastes incorporated treatments were also obtained after the completion of the experiments and analyzed for the moisture, total solids, volatile solids, total organic carbon, total nitrogen, phosphorous and potassium contents following the standard procedures.

Gas Collection

The Biogas produced in each treatment was measured by liquid displacement method on daily basis over a period of six weeks.

Carbon dioxide and methane estimation of the gas generated in the oil cakes incorporated treatments

The carbon dioxide content of the biogas produced was estimated Saccharometer instrument. The methane content was estimated by deducting the carbon dioxide percent from 100. The gas was also ignited and it was allowed to burn. The burning of the gas on ignition was also taken as an index.

Results and Discussion

The percentage degradation of total solids was highest in the treatment AH + 40% CD (66.01%) and lowest in treatment CD (46.79%). The percentage degradation of the volatile solids was highest in the treatment AH + 40% (79.82%) and lowest in treatment CD (60.85%). (Table 1)

As the percentage of cattle dung along with the cakes increases, even the degradation of total solids and volatile solids increases. Total solids and volatile solids were found more in cakes, compared to cattle dung.

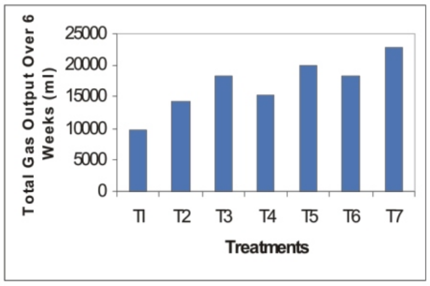

Figure 1 Amount of biogas produced from cakes incorporated treatments

Table 2 Percentage increase in the amount of biogas produced from non edible oil cakes

Treatments	Percentage increase over	
	Cattle dung control	Non edible Oil cakes control
T_1 : CD	-	-
T_2 : JC	44.75	-
T_3 : JC + 40 % CD	86.90	29.77
T_4 : PP	56.10	-
T_5 : PP + 40% CD	103.45	30.96
T_6: AH	85.55	-
T_7 : AH + 40% CD	131.35	25.11

The maximum gas output of 22815 ml was recorded in *Arachis hypogaea* cake incorporated with cattle dung treatment (T7). Among other treatments, *Pongamia pinnata* cake incorporated with cattle dung treatment (T5) recorded 20025 ml. The control cattle dung treatment (CD) alone recorded 9680 ml over six weeks period. (Figure 1, Table 2) Gas output data obtained in this study is found in agreement with the results obtained by Gollakota and Jayalakshmi (1983), Gollakota and Meher (1988), Van Valsen *et al.,* (1979).

An increase in gas production over cattle dung control was observed in all the cakes incorporated treatments. The results indicated that incorporation of cakes with cattle dung enhanced the gas production in the concentrations tested. Moreover, as the percentage of cattle dung increased, along with the cakes, it also increased the gas production. Similar results were also obtained by Rajasekaran (1980).

The maximum degradation of Total Solids (66.01%) and Volatile Solids (79.82%) was observed in the treatment where groundnut oil cake was mixed with 40% of cattle dung. The maximum gas output of 22815ml was recorded over 6 weeks period, indicating an increase of 25.11 % over groundnut oil cake control, and the same was 131.1% increase over cow dung control.

Table 3 Methane content (in %) in the gas generated from cakes incorporated treatments

Treatments	Methane content in %
T_1 : CD	54.5- 58.0
T_2 : JC	56.0-58.0
T_3 : JC + 40 % CD	62.0-65.0
T_4 : PP	56.0-58.5
T_5: PP + 40% CD	63.0-66.0
T_6: AH	59.5-63.0
T_7 : AH + 40%CD	65.0-68.0

The Methane content of biogas was observed to increase gradually with increase in time. The initial methane content was high in treatment AH + 40%CD (65%) and lowest in treatment CD (54.5%) (T3) (Table 3).

The carbon dioxide content of the biogas was observed to decrease gradually with the increase in time. The initial CO2 content was high in treatment CD (43.5%) and lowest in treatment AH + 40%CD (33%). (Table 4).

Table 1 Physical properties of cakes incorporated treatments

Treatments	Total solids (TS) %			Volatile solids (VS) %		
	Initial	Final	%Degradation of ts	Initial	Final	%Degradation of vs
T_1 : CD	12.83	9.53	46.79	10.89	7.11	60.85
T_2 : JC	76.08	38.31	49.65	54.30	19.96	63.25
T_3 : JC + 40 % CD	80.02	36.81	54.01	62.03	19.16	69.12
T_4 : PP	77.43	37.34	51.78	56.43	20.19	64.23
T_5 : PP + 40% CD	81.97	32.99	59.76	63.74	18.83	70.46
T_6: AH	76.13	29.2	61.65	72.18	19.1	73.54
T_7 : AH + 40% CD	80.26	27.29	66.01	79.06	15.96	79.82

Table 4 Carbon dioxide content (in %) in the gas generated from cakes incorporated treatments

Treatments	Carbon dioxide content in %
T_1 : CD	40.0-43.5
T_2 : JC	40.0-42.0
T_3 : JC + 40 % CD	33.0-36.0
T_4 : PP	39.5-42.0
T_5 : PP + 40% CD	32.0-35.0
T_6: AH	35.0-37.5
T_7 : AH + 40%CD	30.0-33.0

Table 5 Manurial values of non-edible oil cakes incorporated treatments with cattle dung

Treatments	Nitrogen (%)	Phosphorous (%)	Potassium (%)
T_1 : CD	1.61	0.64	0.78
T_2 : JC	5.34	0.49	0.34
T_3 : JC + 40 % CD	6.49	0.43	0.44
T_4 : PP	2.39	0.43	0.31
T_5 : PP + 40% CD	2.76	0.26	0.23
T_6: AH	4.23	0.82	0.22
T_7 : AH + 40%CD	5.68	0.78	0.24

The manurial values of the biodigestor and raw samples were examined and presented in Table 5. The nitrogen content of various slurry samples ranged from 1.61 to 6.49 percent in CD and JC+40%CD treatments respectively. The highest phosphorous content of 0.82% was observed in *Arachis hypogaea* with 40% CD incorporated treatment. The potassium content ranged from 0.22 to 0.78 percent. The above data suggest the usefulness of biodigested slurry for possible applications as a fertilizer for crop improvement.

Conclusion

In India, there are many varieties of non-edible oil seed crops where Arachis have great potential for the production of biogas. The oil cakes could thus be profitably utilized for bio gas generation as a supplementary feedstock along with cattle dung. Anaerobic digestion of non-edible oil cake along with cattle dung serve as a better method of augmenting biogas output.

This also provides a better quality renewable gaseous fuel, biogas. Methane content is much pronounced in all the cakes incorporated treatments.

By utilizing such a huge amount of oil cakes for biogas generation, we can solve the energy crisis which is on the increase day by day. This will also help in making our environment clean and healthy.

Besides the methane rich biogas, the biodigested slurry obtained serves as a potential source of organic manure rich in plant food nutrients like N, P and K for application to the fields for improving crop productivity.

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