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**PRODUCTION OF BIOGAS FROM AGRO-INDUSTRIAL WASTE AND *TYPHA*
ANGUSTATA WEED AND ITS ECO-FRIENDLY DISPOSAL**

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ABSTRACT

The world is facing energy problem and to overcome this problem emphasis is mainly given on indigenous and renewable energy sources. This paper deals with the study of biogas production by using Agro- based industrial wastes mainly Distillery, Sugar industry and Dairy waste and *Typha angustata* weed. The pretreated and untreated *Typha* biomass was used, in pretreated biomass there was marked increase in biogas production. Experiments were carried out in 1-L digester flasks; measurement of biogas was done by water displacement method. The biogas production was recorded up to 30 days. The Control sample and pretreated *Typha* showed 85 and 138.67 mL biogas production respectively. Distillery waste can be made to supplement the conventional substrate like dung in urban and rural areas to augment the biogas production and this process of Biomethanation controls the pollution caused by wastes.

Keywords: Renewable energy, biogas, waste, weed

INTRODUCTION

The majority of Indian population lives in villages, where the plant and animal biomass in the form of cattle dung, dry leaves, agricultural residues and plant weeds is available in plenty, which can be easily converted into biogas. To meet the daily

biogas needs of small family on an average, twenty five kg/day of dung will be required and hence the biogas technology even today by and large caters to the need of rich farmers only. In order to replace dung other resources

commonly present in rural areas, has to be used to supplement the biogas production.

The biogas is highly combustible and can be used for generation of heat, electricity and mechanical energy. Biogas is a mixture of methane (65-75%) and CO₂ (30-35%) together with other gases like NH₃, H₂S, H₂ and N₂, etc. in trace quantities, produced from organic matter by microbial decay under anaerobic condition.

In order to produce sufficient biogas, tapping of other resources has become necessity in the light of this a series of publications have appeared to test the potentiality of other forms of biomass. Methane produced by anaerobic digestion of animal excreta like camel, horse, pig, poultry has been compared with that of cow dung [1, 2]. Agricultural wastes like rice straw, Tomato plants and Potato stems 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. *Typha angustata* is grass like, perennial shrub, gregariously growing along margins of ponds, puddles and marshes in temperate and tropical regions in North Asia and North Africa. It was found more or less throughout India. We produce biogas from the weed and waste and simultaneously control the pollution caused by them.

MATERIAL AND METHOD

Materials

Agro-Industrial Wastes

- Distillery waste from of Ajinkyatara Sahakari Sakhar Karkhana, Satara.
- Sugar plant waste from Ajinkyatara Sahakari Sakhar Karkhana, Satara.
- Dairy waste from, M.I.D.C Satara

Typha angustata

Entire *Typha* material was collected from Satara region and used for experiment.

Slurry of Cattle Dung Based Biogas Plant

Cattle dung based biogas plant slurry was collected from a biogas plant situated at Degaon, M.I.D.C. region Satara,

Biogas Digesters

Preliminary screening studies regarding biomethanation potential of weed biomass was carried out by using 1-L capacity glass flasks and plastic carboys.

Methods

Collection, Preparation and Storage of Weed Material

Material collected from different localities, cut into small pieces dried and stored at room temperature

Pretreatment of Weed Biomass- Alkali Treatment

The 25-g of the air dried weed sample was treated with 1% NaOH solution for 8 days, using 10 parts of alkali solution to one part of

the substrate i.e., 25-g of weed sample in 250 mL 1% NaOH solution at room temperature. Untreated and pretreated grass material was stored at refrigeration and used for further studies as and when required.

Chemical Analysis of Weed Biomass and Agro Based Industrial Wastes

Chemical reagents, apparatus and methods used for chemical analyses of weed material and agro based industrial wastes were as per [3, 4, 5].

Biomethanation Study (Table 1, 2)

- a) Control set- Using only cattle dung slurry as substrate
- b) Test sets - Using un treated and pre treated Typha biomass material.
- c) Test sets Using Typha biomass admixed with agro wastes.

Measurement of Gas

It was done by water displacement method

Combustibility Testing

It was done by burning test

Storage of Gas

The biogas in glass bottle was stored in cupboard Due to presence of milk material, the nitrogen at room temperature.

RESULTS AND DISCUSSION

Chemical Nature of Typha

Chemical nature was studied by using standard procedures and details were given in Table 3.

Physico-Chemical Characteristics of Wastes

Table 4 shows the Physico- chemical characteristics of wastes.

Distillery Waste

The C: N ratio was 19.16 indicating its suitability for biomethanation [6, 7], while BOD: N: P (120:4.5:2.77) ratio showed slight deficiency of nitrogen as compared to BOD and phosphorus [6, 7]. Total volatile solids (TVS) content of 64,000 mg/kg further showed its suitability for biomethanation.

Sugar Industry Waste

Total nitrogen and phosphorus were 28 and 3 mg/kg, respectively. BOD: N: P ratio was 120:2.9:0.3 which indicated that the waste was deficient in nitrogen and phosphorus as BOD: N:P ratio needed for biomethanation is 120:5:1, while C:N ratio was 24.64 indicating slight nitrogen deficiency. Enrichment of this waste with N and P could make waste suitable for biomethanation.

Dairy Waste

Due to presence of milk material, the nitrogen content of the waste was high (39.5 mg/kg). The BOD: N: P ratio was 120:3.5:0.4 indicating suitability of the waste for biomethanation after improvement for nitrogen and phosphorus contents. C: N ratio of 20.50 also showed a good biodegradability of the waste.

Biomethanation Study

Biogas production from admixture of Typha and waste was given in **Table 5**.

It was thought that biomethanation of Typha biomass could be improved by admixing with

easily amenable organic materials like distillery, sugar and dairy industry. These wastes would add to organics of admixture, and hence, cause improvement in C: N and BOD: N: P ratios.

Table 1: Screening of Pretreated or Untreated Typha Biomass for Biomethanation Potential and its Admixture Pattern with Cattle Dung Slurry in 1-L Biogas Digesters, Working Volume 600 mL, pH of Digester Material 7.0 Ambient Temperature (28-30°C) and Retention Time 30 Days

S. No.	Amount of daily loading (g)	Proportion of dung slurry admixed with pretreated / untreated biomass slurry at various stages of experiment (g)			
		Stage I 1-10 days : 25% weed material + 75% Dung slurry	Stage II 11-20 days : 50% weed material + 50% dung slurry	Stage III 21-30 day : 75% weed material + 25% dung slurry	Stage IV 31-40 days: 100% weed material
1	20	5 + 15	10 + 10	15 + 5	20 + 0

Table 2: Screening of Pretreated/Untreated Typha Biomasses Admixed with Agro Wastes for Biomethanation Potential and its Admixture Pattern with Cattle Dung Slurry in Biogas Digester. Capacity of Digester – 1-L, Working volume – 600 mL .pH of Digester material 7.0 temperature (28-30°C) and retention time 30 days

S. No.	Volume of daily loading (g)	Proportion of dung slurry admixed with pretreated / untreated weed biomass in combination with agro-based industrial wastes at various stages of experiment (g)			
		Stage I 1-10 days : 25% (weed + waste)+ 75% Dung slurry	Stage II 11-20 days : 50% (weed + waste) + 50% dung slurry	Stage III 21-30 day : 75% (weed + waste) + 25% dung slurry	Stage IV 31-40 days: 100% weed + waste
1	20	5 + 15	10 + 10	15 + 5	20 + 0

Table 3: Chemical Composition of Typha

S. No	Character	Amount
1	Organic matter	73,020 mg/kg
2	Carbon,	42,430 mg/kg
3	Nitrogen,	2040mg/kg
4	C : N ratio	20.80
5	BOD,	39,110 mg/kg
6	Phosphorus,	150 mg/kg
7	Potassium,	1400mg/kg
8	Calcium,	1600 mg/kg
9	Magnesium,	780 mg/kg
10	Iron,	110 ppm
11	Manganese,	110 ppm
12	Zinc,	49 ppm
13	Copper,	5 ppm
14	BOD : N : P ratio	120:6.3 :0.46

Table 4: Physico-chemical Characteristics of Different Wastes

S. No.	Parameter	Distillery waste Value/Obs.	Sugar Industry Value/ Obs.	Dairy Value/ Obs.
1)	Colour	Dark brown	Yellowish brown	Dirty white
2)	Odour	Alcoholic noxious	Unpleasant	Unpleasant
3)	pH	4.2 – 4.5	6.2 – 6.4	6.3 – 6.6
4)	BOD mg/kg	41290	1150	1350
5)	COD mg/kg	112000	1830	2100
6)	Total solids mg/kg	95000	2200	1320
7)	TVS mg/kg	64000	1950	1200
8)	TOC(Carbon) mg/kg	29700	690	810
9)	Nitrogen mg/kg	1550	28	39.5
10)	Phosphorus mg/kg	950	3	4.6
11)	C:N ratio	19.16	24.64	20.50
12)	BOD : N : P ratio	120 : 4.5: 2.77	120 : 2.9 : 0.31	120 : 3.5 : 0.4

Table 5: Biogas Production From Admixture of *Typha angustata* and Agro Industrial Wastes (UT- Untreated, PT- Pretreated)

Sr.No	Type of plant and Agro waste	Nature of waste	Range of gas mL	Average gas Production mL
1	Control(cow dung)	-	60-90	85.00
2	<i>Typha angustata</i> (<i>Ta</i>)	UT	60-100	82.67
	(<i>Ta</i>)	PT	100-190	138.67
3	Distillery waste	UT	190-340	275.00
	(DW)	PT	270-380	319.00
4	Sugar industry	UT	130-200	169.50
	(SI)	PT	140-250	187.40
5	Dairy industry	UT	110-140	121.00
	(DI)	PT	125-210	176.50

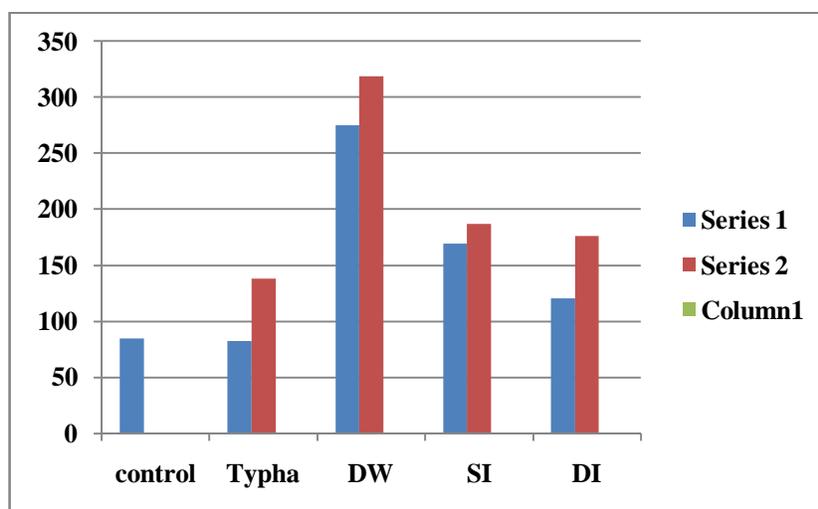


Figure 1: Biogas Production in mL in Untreated and Pretreated Typha Biomass Along With Agro Industrial Wastes

DISCUSSION

Agro Industrial wastes like distillery, sugar and dairy are available in large quantities. The hundreds of cubic meters of wastes were produced daily in these industries.. All of them possess huge pollution potential with respect to their volumes and organic content. These wastes, if disposed into water bodies and land or soil environments without prior treatment, can cause severe environmental problems. The organic content of these wastes hinted at their utilization to the processes like biomethanation along with weed biomass to generate energy in the form of biogas, and sludge and effluents as supplement to manure and fertilizer. Further, the process will cause reduction in environmental pollution.

Biomethanation Potential Studies

Distillery Waste

It was found that Typha biomass material after admixing with distillery waste, when fed to 1-L biogas digesters, showed expected increase in the biogas volume (**Table 5**). The distillery waste is a well known substrate for biomethanation, which is proved in the present studies as well as by many other workers earlier [8]. The chemical characteristics of distillery waste in the present studies showed that it possess high level of TVS at 64,000 mg/kg and more organic carbon as compared to N and P, and

hence, if it is admixed with substrates containing higher levels of N and P, the biomethanation can be improved. It has been observed in the present studies that amount of biogas increases when Typha biomass was admixed with distillery waste for use as substrate for biomethanation. The expected pattern of increase in the biogas volumes was observed when pretreated biomasses of weeds after admixing with distillery waste were used as biomethanation substrate.

Sugar Industry Waste

It was observed that admixing of untreated and pretreated weed biomasses with sugar industry waste caused increase in the volume of biogas produced as compared to the untreated and pretreated weed biomass alone (**Table 5**). It was evident from chemical analysis of sugar industry waste that it contained more BOD but less N and P, while Typha material contained comparatively more N and P, which caused improvement in BOD:N:P ratios, and hence, admixture of Typha biomass and sugar industry waste showed improved biomethanation as compared to Typha biomass alone.

Dairy Industry Waste

The dairy industry waste contained more BOD and TVS but comparatively low N and P; hence alone it was not much suitable for biomethanation. It was found that when

untreated or pretreated weed biomass was admixed with dairy waste and used as substrates for biomethanation, it improved the biomethanation efficiency as compared to use of weed biomass alone (**Table 5**).

In the present studies regarding screening of combined substrates for biomethanation. Typha biomass (untreated and pretreated admixed with industrial wastes (distillery, sugar and dairy wastes), it was observed that more biogas production was obtained in pretreated Typha alone as compared to untreated one, and in the admixture of pretreated Typha biomass and other wastes as compared to untreated Typha biomass and wastes, among the three wastes studied the distillery waste was the best substrate for biomethanation (**Table 5 and Figure 1**). Taking into account the amount of biogas produced, both in the pretreated and untreated Typha biomass in the admixture with distillery waste, it was observed that slightly higher amount of biogas production was obtained after pretreatment of biomass but additional cost of alkali needed and time required for pretreatment (7 days). Hence, it was suggested to use untreated biomass admixed with Distillery waste as the best combination amongst the lot.

CONCLUSION

1. The biomethanation process was studied up to 30 days at ambient temperature (28–30°C)
2. Untreated Typha biomass was proved comparatively a poor substrate for biomethanation than pretreated biomass.
3. Cow dung alone was not found to be good substrate for biomethanation but when admixed with Typha biomass and Agro-based industrial waste gives good potential.
4. Chemical analysis of Typha and distillery waste show C: N and C: N: P ratio was in desirable range for biogas production.
5. In the present studies pretreated Typha biomass and distillery waste admixture proved to be the best substrate.
6. The volume of biogas production from pretreated Typha and Distillery waste was 319.00 mL
7. The project could help to remove Typha and agro industrial wastes from the area. The effluent and sludge produced after Biomethanation used as a fertilizers.

8. Biomethanation process is eco-friendly that can achieve the goal of the zero pollution.

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