**ANAEROBIC DIGESTION OF DRIED LEAVES ( *samanea saman*) FOR BIOGAS PRODUCTION AND MANURE DEVELOPMENT**

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**ABSTRACT**

Biogas appears to have potential as an alternative energy source particularly for rural community. The technology is simple and is booming in the world energy markets. Biomass resources are being available worldwide, new high technology with improved efficiency plants have been introduced. While based on ongoing research and development in this field smart biogas plants will be in operation soon. The biogas plants can be used wherever the bio-waste is available/ dumped. The study suggests that biogas technology must be encouraged, promoted, and invested in for implementation and demonstration, especially in remote rural areas. In this work, the anaerobic digestion using microalgae and their residues, resulting from biogas digester for biodiesel production, using two inoculums (sludge and poultry manure) for biogas production was investigated. It was found that the biogas production from digestion of micro algae residue with sludge reached values similar to those obtained with raw bio algae. Both the volume of biogas generated from the microalgae residue from the extraction process of its biochemical estimation (pH, Nitrogen, Phosphorus and Potassium) and the quality of the biogas produced reflect the value of this residue to be vaporized by anaerobic digestion. This approach based on a bio refinery concept and focusing on the anaerobic digestion process could be a key technology for energy production from biomass.

**Keywords:** Biogas, Digestion, Microalgae, Sludge, Poultry manure, Anaerobic digestion,

**INTRODUCTION**

For sustainable development a basic requirement of adequate resources are needed, particularly energy services, to satisfy the basic needs of an individual and the society for improving the social welfare and economic development **(Alemayehu *et.al.* 2015).** Energy as an input for goods and services is a prerequisite for economic development. Energy is obtained from both renewable and nonrenewable sources. The energy of the future must be regenerative and sustainable and bioenergy (biogas) biological conversion of organic materials/waste by anaerobic digestion using engineered reactors has the potential. Anaerobic digestion is a technology widely used for treatment of organic waste for biogas production

Efforts to reduce the enormous environmental impacts and associated human health and socio economic implications by shifting to efficient and cleaner biomass-derived fuels (biogas) have had more success, it should be done through energy production. Climate goals and rural livelihoods are positively contributed by the production of Biogas. **(Akinbami *et.al.,* 1996).**

Biogas is a type of bio fuels called a biogas originates from biogenic material produced by bacteria fermentation of organic material under anaerobic condition (in the absence of oxygen). It can be produced from a wide variety of available organic materials and wastes, including sewage sludge, animal manure, and municipal organic waste **(Ismail et.al.2016).** Biodegradable waste, straw, manure, sugarcane and by-products from agricultural and industrial processes are the materials which are required and specially grown energy crops can also be used for the production of energy.

The widely used simple technology is the anaerobic digestion for processing the biodegradable, organic waste for the biogas production. Animal manure (cow dung) is used as inoculums, pre-treatment of substrate **(Talib *et.al.* 2016).** The thermophilic conditions are responsible to improve the biogas yield by approximately 92%. The organic waste can be fermentated and it involves biological and chemical, and the process is equally beneficial in waste management.

During the process, biomass the large organic polymers are broken down into smaller molecules by chemicals and microorganisms. After completion of the anaerobic digestion process, the biomass is converted into biogas, (methane, carbon dioxide and traces of other contaminant gases), as well as liquid digestate (nutrient rich fertilizer) **(Raja *et.al.,* 1997).**

Rain tree (samanea saman) The rain trees (Samanea saman) which are mostly present in Rabiammal Ahamed Maideen College For Women, Tiruvarur, which are over 25 meters high and can live for more than 25 years, produce large quantities of waste all year long, due to their leaves and branches shedding and it is also called as ‘monkey pod tree’ and in this study it is taken as one of the inoculums to produce biogas and also act as fertilizer .

 It is reported that mixing food scraps and rain tree leaves in compost provided a better alternative to chemical fertilizer (considering the amount of grain produced). This mixed compost soil contained 1.25% nitrogen, 0.15% phosphorus and 0.38% exchangeable potassium, whereas soil without fertilizer has 0.05%, 0.01%, and 0.02% of nitrogen, phosphorus, and potassium, respectively **(Suntararak *et.al.,*2014).**

**MATERIALS AND METHODS**

 **Feedstock and inoculums**

The dried fallen Rain leaves (Samanea saman) were collected from Rabiammal Ahamed Maideen College for Women, Tiruvarur (18°56′14″N; 99°3′38″E), and Tamilnadu, India. Rain tree leaves were crushed by machine into small particles. The crushed leaves were dried in an oven at 40 °C for 48 h to achieved a moisture content of < 10% then reduce to a particle size of 0.5–1 mm using a blender (OTTO BE-127 blender). The dried powder was stored and sealed in a desiccator under ambient temperature for further usage. The inoculum was collected from a Galileovasan Offshore Research and Development Private Limited, Nagapattinam, Tamilnadu, India. It was kept in air-tight buckets at 4 °C in a walk-in cooler. Prior to use, the inoculum was acclimated and degassed at 35 °C for 3 weeks to minimize the effect of methane production from inoculum.

**Algae culture (Chlorella vulgaris)**

A total of 500ml of cultured microalgae was collected and were kept in a Biogas Digester (total volume = 22.0 L) for the production of a large amount of biomass through N-2 Balanced Salt solution medium. The medium was prepared with rice fertilizer (100 g), rice bran (400 g), fish meal (100 g), lime (50 g), and urea (200 g). The Biogas Digester has the dimensional of width and height was 80 and 40 cm, respectively. The Biogas Digester was filled with 10 L of water and medium, a total of 10 L of water and mixed ingredients were to a Biogas digester which was connected with an air pump.

The pond was left for one night to release ammonia and to allow the medium to dissolve in the water properly. The stock algae were transferred in the following day to the triplicate Biogas Digester. Algae growth was measured and recorded every day. Additionally, the pond was stirred every day to prevent precipitation of the algae.

**Materials for Biogas productions**

* Digester dried leaves
* Digester feed stock (Animal dung)
* 20-litre water can
* 1/4" plastic tubing - possible use in the gas collection system
* Medium size Tyre tube for gas storage
* Tub for mixing water feedstock
* PVC Pipe 3/4" 2.5 ft
* T-valve
* Super Glue
* Fine Sand
* Soldering Iron
* Black Colour Paint

**Estimation of available Nitrogen (Zhang changai *et.al.* 2011)**

To determine the nitrogen content of organic and inorganic samples, the Kjeldahl method is used. For more than a century, the Kjeldahl method has been used to determine nitrogen in a wide range of samples. *Johann Kjeldahl*, a brewer, invented the Kjeldahl method in 1883. The protocol is based on the idea that strong acid aids in food digestion by releasing nitrogen, which can be measured using a suitable titration technique.

**Estimation of available Phosphorous (Gao yuhuan *et.al.* 2011)**

The total phosphorus content in biogas slurry was determined via H2SO4-H2O2 digestion and the vanadium-ammonium Molybdate-colorimetry method. Ammonium molybdate reacts with acid to form the heteropoly acid molybdophosphoric acid in a dilute orthophosphate solution, vanadomolybdophosphoric acid is formed in the presence of vanadium.

**Estimation of available Potassium (Gao yuhuan *et.al.* 2011)**

The total potassium content in the biogas slurry was determined via flame photometry. The utilized test solution was identical to that used for the total phosphorus determination as described. All further specific procedures were identical to that for the determination of effective potassium content in slurry.

**Estimation of PH in slurry sample (Itodo and Awulu, 1999)**

A glass electrode in contact with hydrogen ions of the slurry sample, acquired an electric positional which depends upon the concentration of HAs. This is measured against some reference electrode. This is usually a calomel electrode. The potential between the glass electrode and calomel electrode is expressed in PH units.

**RESULTS AND DISCUSSION**

The purpose of this work is to implement the ways for the production of Biogas by the use of local resource with alternate sources .This is the basics of anaerobic digestion and production of gas by different organic kitchen wastage. The main thing is to design, prepare , and test a simple waste digester and gas collection system. One can check various facets of the anaerobic digestion process.

**Substrate**

Among the physical and chemical characteristics of substrates fed to the digesters the N and P ratios in biogas digester were 14 and 64, respectively. Substrates with C/N ratios of less than 15 and C/P ratios of less than 75 are most suited for stable biological conversions. This indicates *samanea saman* leaves have potential as a substrate for biogas production in India. The N, P, K content of *samanea saman* leaves accounts for their usefulness as green manure in India.


### Figure no 1. Effect of anaerobic Digestion on the amount of fertilizer elements Nitrogen of *Samanea saman* Leaves

The value of Nitrogen fluctuates initially 0 the maximum value **(1.68 %)** was recorded in the initial stage of the experiment has decreased and the high values of nitrogen in final stage **(1.70%)** of the gas production activity were to be increased could have also contributed to the inorganic nitrogen content. Similar results reported by **(Arvind kumar *et.al*. 2022).**


### Figure no 2. Effect of anaerobic Digestion on the amount of fertilizer elements Phosphorus of *Samanea saman* Leaves

The value of Phosphorus fluctuates initially 0 the maximum value **(0.80%)** was recorded in the initial stage of the experiment has decreased and The high values of phosphate in final stage **(0.90%)** of the gas production activity were to increased could have also contributed to the inorganic phosphate content. Similar results reported by **(Arvind kumar *et.al.,*2022).**


### Figure no 3. Effect of anaerobic Digestion on the amount of fertilizer elements potassium of *Samanea saman* Leaves

The value of potassium fluctuates initially 0 the maximum value **(0.20%)** was recorded in the initial stage of the experiment, and the high values of potassium in final stage **(0.50%)** of the gas production activity could have also contributed to the inorganic potassium content. Similar results reported by **(Arvind kumar *et.al.* 2022).**

|  |  |  |
| --- | --- | --- |
| **TOTAL NITROGEN** | **TOTAL PHOSPHOROUS** | **TOTAL POTASSIUM** |
| **1.70 %** | **0.90%** | **0.50%** |

### Table no 1: Nutritional contents of biogas slurry

**pH**

10.00

9.00

8.00

7.00

6.00

5.00

4.00

3.00

2.00

1.00

0.00

8.00

7

5.5

5.5

1 2 3 4

Time, Weeks

**Figure no 4. Changes in pH in Leaves during batch fermentation of *Samanea saman* leaves**

The dried leaf inoculums of 1 liter of digested slurry with a PH of 8.2 provided buffering capacity as well as a high concentration of facultative and obligate anaerobes. The PH in the dried leaf treatments (Figure. 4) was within the desirable range of 6.6 to 8-2 and it concluded as hence methane production started immediately till the end of the third week there was no methane production. The digestion upset occurred because of organic overload. However, in the fourth week the PH increased to an acceptable level of 6.8 and methane production started. The experiment was terminated at the end of the fourth week to maintain uniform operation period for all the treatments.

Ammonium can be used by crops when it is applied to fields. Also, the biogas slurry is rich in readily available N, P, and K, which are vital nutrients for plants. According to reports, the availability of N from digested slurry directly affects the yield during the growing season, whereas the availability of P and K can be measured over the course of the following year or several years.

Due to the higher nitrogen availability and superior short-term fertilization effect, the digestate from anaerobic fermentation is a beneficial fertilizer. Pathogen survival is reduced during anaerobic treatment, which is crucial if the digested residue is to be used as fertilizer**.**

In this study, with its high concentrations of nitrogen (N), phosphorus (P), potassium (K), and other trace elements, biogas slurry is employed as a biofertilizer and as a biological insecticide due to its high concentrations of amino acids, growth hormones, and antibiotics, all of which encourage plant growth.

This work, reported that biogas slurry contains abundant nitrogen, which is a readily available nutrient. After fermentation, the content of ammonium ions (NH4+) and pH of the biogas slurry increased, while the concentration of carbon (C) from the dry matter decreased, and the C/N ratio also decreased.

Moreover, compared to conventional fertilizers, biogas slurry provides higher N that is easily available to plants. The accessible nitrogen, which includes inorganic nitrate (NO3) and ammonium (NH4) as well as simple structured organic nitrogen derived in part through the decomposition of organic materials, can be directly taken by plants.

## SUMMARY AND CONCLUSION

Anaerobic digestion is an important technology which is used for the production of biogas. This technology is simple and it can be readily use in domestic and farming applications. It can contribute substantially to the sustainable energy recovery from organic waste particularly agriculture and municipal. Apart from significant energy source, comprehensive utilization of biomass, agricultural, animal husbandry, forestry and fishery residues are important and, thus controlling the pollution and meeting the environment. The biogas technology provides two important benefits: environmentally safe waste management as well as the generation of clean renewable energy. From this study, Biogas was obtained from the organic waste which gives a renewable energy. It produce valuable fertilizers for agriculture. It reduces global warming effect by reducing methane formation from organic waste and animal dung. It is also possible to convert Bio-gas may into biomethane for automobile fuel.

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