

# Biogas Production from Sawdust Waste, Cow Dung and Water Hyacinth-Effect of Sawdust Concentration

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## ABSTRACT

*Sawdust, generated by numerous sawmills situated along rivers, poses a great problem, as it gradually encroaches into the river causing environmental menace to aquatic life. This work proposes the utility of sawdust, co-digested with cow dung and water hyacinth to generate biogas as a means of its disposal. Varying amounts of sawdust waste complimented with a fixed amount of cow dung and water hyacinth was anaerobically fermented in batch-fed digesters, in the laboratory, at the same operating conditions. Biogas was measured for a period of 64 days at an average ambient temperature of 30°C. The results show that efficient biogas production rate was maximum (0.045litres/TS fed) when about 11.48g of sawdust waste was digested in a fixed amount of cow dung and water hyacinth (7g). This corresponds to about 8 to 9.5% total solid content in the anaerobic digester which lies within the recommended percentage range for optimum biogas production.*

**Key words:** Saw dust, Cow dung, Water hyacinth, biogas, anaerobic digestion.

## 1. INTRODUCTION

Biogas is a gas produced via the breakdown of organic matter in the absence of oxygen. It is produced by the anaerobic digestion or fermentation of such biodegradable materials as biomass, manure, sewage, municipal waste, green waste, plant material and crops [1]. Biogas is also generated by converting cow manure via anaerobic digestion into methane biogas [2]. One cow can produce enough manure in one day to generate three kilowatt hours of electricity whereas only 2.4 kilowatt hours of electricity is needed to power one hundred watt light bulb per one day [2]. In some parts of the world, like Nepal, biogas is a reliable source of rural electricity. Also, by converting cow manure into methane biogas instead of letting it decompose, global warming gases could be reduced by 99million metric tons or 4% [3]. Furthermore, biogas can be utilized for electricity production on sewage works [4] in a combined heat and power engine (CHP), where the waste heat from the engine is conveniently used for heating the digester, cooking, space heating, water heating and process heating. If compressed, it can be used as fuel in internal combustion engines or fuel cells [5].

Sapele, a renowned city in Nigeria, reputable for its timber and plywood resources, faces the menace of sawdust waste disposal. Also, deciduous rainforest areas, characterized by high rate of lumbering activities are faced with the same menace. Virtually all sawmills therein are located along the river banks, and disposal of the sawdust waste is by the riverside, where sometimes it is burnt. This action releases carbon dioxide (CO<sub>2</sub>) to the atmosphere, resulting in environmental air pollution. However, due to the constant rainfall in the region, burning is often terminated, consequently increasing the concentration of heaps of sawdust which seriously encroach into the river as suspended solids reducing the width of the river and invariably becoming a nuisance to the aquatic environment.

In recent years, biogas systems have attracted considerable attention as a promising approach for organic wastes recovery. Developed and developing countries and several international organizations have shown interest in biogas systems with respect to various objectives:

biogas is a renewable source of energy which can relieve the burden of dependence on fossil fuels as bio fertilizer: Nitrogen, phosphorus and potassium are conserved in the process of biogas production and can be recycled into agricultural lands as fertilizer.

public health and hygiene: It reduces the concentration of pathogens considerably, thereby breaking the cycle of reification and leading to improved public health.

waste recycling: It utilizes different kinds of wastes.

environmental management: It is a multifaceted technology which can be applied to a variety of environmental and social milieus.

Also, due to eutrophication of tropical water bodies, water hyacinth (*Eichhomia crassipes*) invades them and creates an imbalance in the lifecycle of these water bodies. In order to naturally control their invasive nature, water hyacinth could be harvested and used for anaerobic digestion[6].

## 2. MATERIALS AND METHOD

Buckner flasks and measuring cylinders were employed in the experiment. They were properly washed with soap solution and washing brushes, and allowed to dry by standing over night in the laboratory. The corks, connecting pipes, cheesecloth were washed with soap solution and also allowed to dry as above. Sodium chloride (NaCl) was employed as the saturating agent. Distilled water was used for all dilutions. Also weighing crucibles and evaporating dishes were employed and properly cleaned before use.

## 3. Experimental Set-Up

The experiment was based on batch-type digester, being the simplest form of digestion. Biomass was added to the reactor at the start of the process in batches and was sealed for the duration of the process. 500-ml capacity Buckner flask digester was used as the batch reactor and biogas collection was done via water displacement method [7].

## 4. RESULTS AND DISCUSSION

The general results obtained from the experiment show that varying the amount of saw dust blended with a fixed amount of cow dung and water hyacinth in water is critical for producing maximum amount of biogas in a period of 64 days with an average ambient temperature of 30°C.

The results indicated that there was the presence of biogas-producing bacteria and that the conditions for biogas production were attained within the given period of the experiment.

The tendency of the curves towards a constant value at steady state shows that the total amount of the gas available from the systems could be chosen for future studies. The values obtained at the end of the experiment were different for each system which is an indication that the micro-organisms acted on the basis of the availability of the volatile fatty acids readily available for biogas production during the methanogenesis stage.

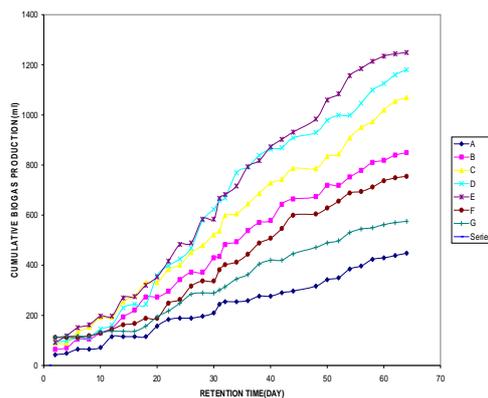


Fig. 1

The graphs show a progressive increase in the cumulative biogas production for digester A to G. This could be attributed to the fact that anaerobic digestion of organics proceed best if the fermentation slurry consists roughly of about 8% total solid content [7]. The gradual decrease observed in F and G could be ascribed to the fact that the total solid content in both digesters are beyond the specified range for optimal biogas production.

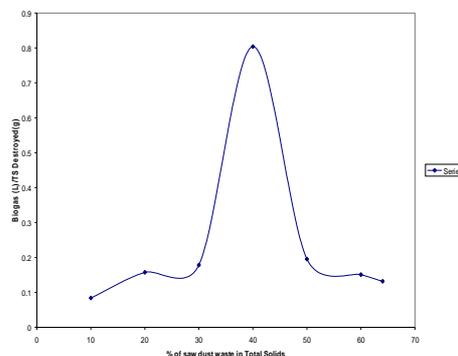


Fig 2 Plot of Average Rate of Biogas Production versus Saw dust Concentration

The graph of average rate of biogas production against saw dust concentration, in figure 2, shows that there was gradual increase in the average rate of biogas production as the concentration of saw dust waste is increased until a peak value is reached after which the average rate of biogas production starts falling. This can be attributed to the fact that as the concentration of the saw dust waste increases, the lignin content in saw dust, which is not easily degraded, also increases until a peak is reached when the anaerobic system will experience a lesser bacterial count to biodegrade the massive lignin form of carbon in the saw dust and consequently leading to gradual decrease in the amount of biogas production. The peak value obtained from the graph shows an average rate of biogas production of about 0.039litres biogas per day with a corresponding saw dust waste concentration of 14.85g. This is 51.48% of saw dust waste in the total solid content of 7g each of cow dung and water hyacinth respectively.

## **5. CONCLUSION**

- 1.** Biogas can be produced from the digestion of saw dust, water hyacinth and cow dung.
- 2.** A blend of 7g each of cow dung and water hyacinth with 15g of sawdust (indicating a total solid content of 8-9% fermentation slurry) is most suitable for biogas production.
- 3.** The rate of biogas production increases as the concentration of saw dust waste increase until it peaks at 0.039litres per day (corresponding to 51.48% of saw dust concentration) when it starts decreasing due to decreasing number of methanogenic bacteria which are active only within a particular concentrate of cellulose substrates.
- 4.** The utility value of sawdust can be harnessed from anaerobic digestion of it, leading to biogas yield.
- 5.** The environmental menace of saw dust from lumbering activities can thus be curbed.
- 6.** Water hyacinth can be harvested from water bodies and used for biogas production.

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