Comparative Analysis of Biogas Produced from Treated Oil-Palm Husks

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***Abstract*:- Production of biogas from oil palm husks treated with enzyme and alkaline for seven weeks were investigated. The physicochemical and bacteriological characteristics of the treated oil palm husks using standard techniques were also determined. The ash content, moisture content, nitrogen, total solid, organic carbon, fat, volatile matter before and after digestion of oil palm treated with enzyme were 2.60 – 2.85, 3.56 – 2.10, 0.68 -0.30, 96.44 -92.12. 87.85 -84.01, 97.40 -91.50, 0.3. -0.50 and 5.99 – 3.51 while that of oil palm husks treated with alkaline were 2.24 - 2.40, 3.51 – 2.50, 0.73 – 0.50, 96.49 – 94.08, 89.16 – 87.28, 97.76 – 94.17, 0.30 – 0.55 and 5.09 – 4.02 respectively. The bacteria isolated were *Bacillus subtilis, Bacillus megatonium, Pseudomonas aeruginosa, Clostridium sporogenes and Bacillus cereus*. The cumulative biogas yielded from enzyme treated oil palm husks and alkaline treated oil palm husks were 111ml and 109ml respectively. The study shows that both treatments can yield biogas when used to treat oil palm husks but enzyme treated oil palm husks has a greater potential to generate more biogas**

I. INTRODUCTION

The palm oil industry generates large quantity of wastes whose disposal is a challenging task such as oil palm husk (23%), mesocarp fiber (12%) and shell (5%) for every ton of fresh fruit bunches (FFBs) processed in the mills (Prasertsan and Prasertsan, 1996). Fresh fruit bunches are sterilized after which the oil fruits can be removed from the bunches, the empty oil palm husks are left as residues almost 70% of the bunches are turned into wastes. Empty oil palm husks are abundantly available as fibrous material of purely biological origin. It contains neither chemical nor mineral additives and depending on proper handling operations. Since the moisture content is around 67%, pre-processing is necessary before it can be considered as a source of good fuel. This by-product can be converted to value-added product or energy to generate additional profit for the palm oil industry. Oil palm biomass residues composed of cellulose, hemicelluloses that could be used as substrate for methane production by anaerobic digestion (Kelly-Yong, 2007). Pre-treatment steps such as shredding/chipping, dewatering (screw pressing or drying), addition of alkali and enzyme e.t.c. are necessary in order to improve the fuel property of empty fruit bunch. Pre-processing of empty oil palm husks will greatly improve its handling properties and reduce the transportation cost to the end user i.e., power plant. Under such scenario, kernel shells and mesocarp fibres which are currently utilized for providing heat for mills can be relieved for other uses off site with higher economic returns for palm oil millers. Biological degradation of organic matter under aerobic condition and anaerobic condition is a key process within the natural metabolism of ecosystem (Thomson, 2004). Biogas is a combustible gas produced by the biological breakdown of organic matter by microorganisms (methanogens) in the absence of oxygen (i.e. anaerobic condition) (Ilaboya *et al*., 2010). Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant materials, sewage, green waste, etc. Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest materials inside a closed system. Biogas is primarily methane (CH_4) and carbon dioxide (CO_2) and traces of other gases such as hydrogen sulfide, ammonia, carbon monoxide, hydrogen, water vapor, etc. (Edelmann *et al*., 1999).Anaerobic process could either occur naturally or in a controlled environment such as a biogas plant (bio-reactor). Organic waste such as livestock manure and agricultural waste are put on an airtight container called digester (Bio-reactor) (Ojolo *et al.*, 2007). Therefore, the aim of this work is to produce biogas from oil palm husk treated with alkali and enzyme.

II. MATERIALS AND METHODS

Collection of Samples

Empty oil palm husks were collected from oil producing industries in Okitipupa in Ondo State, Nigeria and identified in the laboratory at Department of Agricultural Technology, Rufus Giwa Polytechnic, Owo, Ondo State, Nigeria.

Preparation of Samples

Empty oil palm husks were sundried and ground into powder with the aids of electric grinder. 20 kg each of the powder samples of palm oil husks was measured into two separate bowls, enzyme (Cellulase from *Trichoderms reesei*) was added to one bowl while 95g NaoH solution (8% w/v) was added to second bowl, mixed thoroughly for 10 minutes at room temperature and incubated. The mixtures were centrifuged at 10000rpm at room temperature for 6 minutes in order to degrade the cellulose in the oil palm husks (Zhang *et al*., 2011)

Isolation and Characteristics of Bacteria

One milliter of each sample of the slurries was aseptically diluted serially. 0.1ml of serially diluted samples were introduced into empty petri-dishes after which nutrient agar was pour and swirled gently on the table for even distribution and these were allowed to solidify. The petri-dishes were covered and incubated in an inverted position at 35^{o}C for 24hours. The bacterial isolates were characterized on the basis of their morphological and biochemical characteristics carried out by Cheesbrough, 2006 and Holt and Krieg, 1994

Construction of Bioreactor

50litres Bioreactor consisting of electric motor and petrol engine with outlets to feed and let out the substrates and connected with hose to gas cylinder for gas collection was constructed for biogas production.

Preparation of Slurry

From the treated samples, slurries were prepared from each sample and used for the investigation. 10kg of treated sample was mixed with 10liters of distilled water and transferred into bioreactor for gas production (Sagagi, 2009).

Determination of Physicochemical Properties of Treated Oil Palm Husks

Physicochemical properties of treated oil palm husks were determined before and after biogas production according to AOAC, 1990. Parameters such as Ash content, Moisture content, Nitrogen, Total solid, Organic carbon, Organic matter and Fat were determined.

Production of Biogas

10kg of treated oil palm slurries from each sample was transferred into the bioreactor and distilled water was poured into the bioreactor after which nutrient broth containing mixed mixture of microorganisms was added and the bioreactor was sealed up and stirred thoroughly. Delivery tube was connected to the bioreactor to collect the gas. The experiment was set up for seven weeks at ambient condition and was continuously stirred to ensure that the molecules of gas are set in perpetual random motion until a decline in gas production was observed (Ilaboya *et a*l., 2009)

III. RESULTS AND DISCUSSION

The evaluation of biogas productivity potential from oil palm husks treated with enzyme and alkaline were examined. Figure 1 and 2 show oil palm husks treated with enzyme and alkaline characteristics used in this study. Pretreatment of oil palm husk is necessary to open its digestibility and subsequent the degree of conversion. The nutrient values such as Ash content, Moisture content, Nitrogen, fat as well as chemical composition were analyzed before and after digestion period to measure the degradability through substrate depletion which will also contribute to the biogas production. The initial total solid and volatile matter were different from those after digestion. The initial total solid reduced from 96.44 to 92.12 and 96.49 to 94.08 and volatile matter reduced from 5.99 to 2.48 and 5.09 to 4.02 for oil palm husks treated with enzyme and alkaline respectively after digestion (Fig. 1 & 2). This is attributed to the difficulty in the lignocelluloses structure of oil palm husk to degrade hence chemical or biological pretreatment of oil palm husks is required to help in biogradation and biogas production (Pornwimon *et al*., 2019).The reduction was greater in oil palm husks treated with enzymes when compared with the one treated with alkaline. The volatile matter gives rough approximation of the amount of organic matter present in solid fractions of waste (APHA, 2005). Low volatile fraction in the study shows low biodegradability and low biogas production.

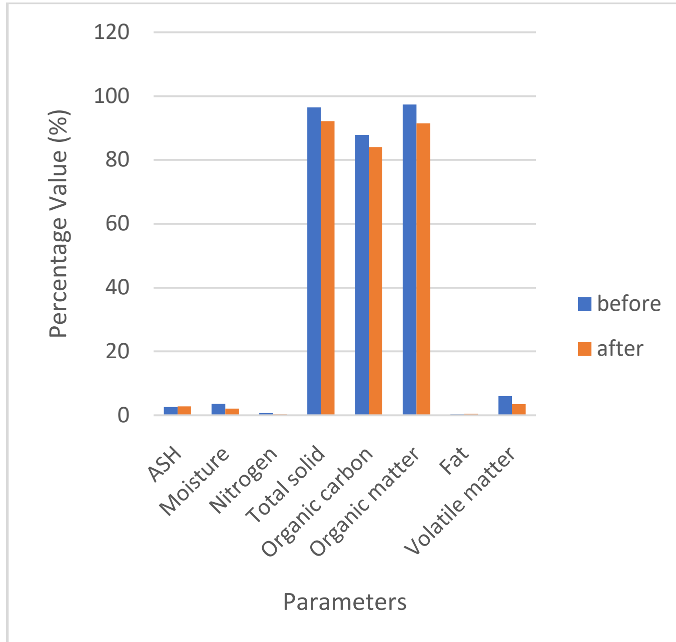

Figure 1: Physicochemical Analysis of Oil Palm Husk Treated with Enzyme

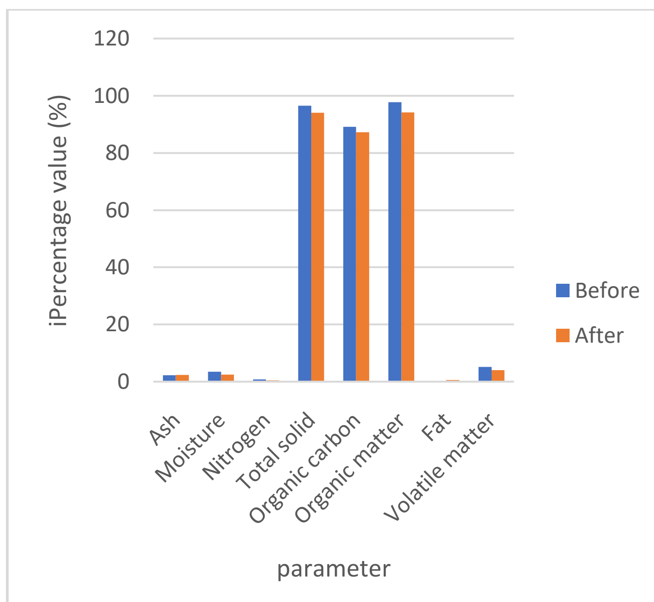

Figure 2: Physicochemical Analysis of Oil Palm Husk Treated with Alkaline

Oil palm husks have high organic matter and high carbon content which is suitable to boost the production of biogas.

When cellulose and hemicellulose is associated with hexose and pentosans sugars, it undergoes rapid decomposition but when associated with lignin, the rate of decomposition is very slow. Lignin is considered as recalcitrant compound that hardly degrades by microorganisms. Figures 1 and 2 show that Ash content and fat content for both oil palm husks treated with enzyme and alkaline increased after digestion for seven weeks while moisture content, Nitrogen, organic carbon and organic matter for both oil palm husks treated with enzymes and alkaline reduced. The rate of reduction in all the parameters in oil palm treated with enzymes were greater than that of alkaline.

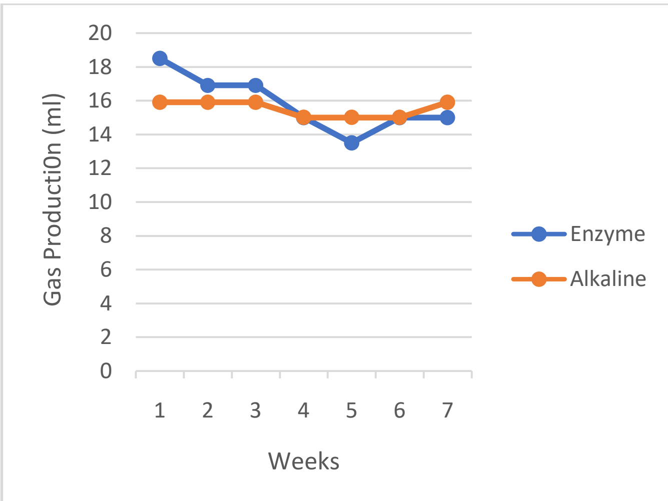

Figure 3:Gas Production from Treated Oil Palm Husks

It was also observed in fig. 3 that oil palm husks treated with enzymes produced the higher volume of biogas (18.5ml) after one week compared with the one treated with alkaline which produced 15.9cm^3 of biogas. There is reduction in the volume of biogas produced in oil palm husks treated with enzyme till seventh week while oil palm treated with alkaline produced constant volume of biogas from first week to third week (15.9 ml) and later decreased (15.0 ml) till sixth week before increased on seventh week. This could be due to a slowdown in biodegradability of complex materials and degradation of remaining readily biodegradable materials. Also remaining readily biodegradable materials of the substrates would have been entrapped within cells by cell wall that contained cellulose so they were not easily accessible for microbial degradation (Taherzadeh and Karmi, 2008). Total volume of 111ml of biogas was produced from oil palm husk treated with enzymes while 109ml of biogas was produced from oil palm treated with alkaline. The bacteria isolated were *Bacillus subtilis*, *Bacillus megatonium*, *Pseudomonas aeruginosa*, *Clostridium sporogenes* and *Bacillus cereus.* Most of these bacteria help in the production of biogas because they are either anaerobic or facultative anaerobic.

IV. CONCLUSION

The anaerobic digestion of the treated oil palm husks with enzyme and alkaline is feasible though the biogas production was low. It was established in this study that treatment of oil palm husks with enzymes and alkaline was able to produce biogas but greater production of the gas was established using enzyme hence enzyme treated oil palm husks is recommended for higher yield of biogas

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