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Original Research Article

Augmentative Invention of Biogas from the Agronomic Wastes Using Facultative Anaerobic Bacterial strain

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A B S T R A C T

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The study was done with three varieties of Agrowaste of sample such as fruit waste, vegetable wastes and cowdung. The aim of this study was to determine the augmentative bacterial organism act as an enhancing agent for biogas production. From this study shows when the two experimental microbes such as the *E. coli* and *Lactobacillus* species subjected with its stipulated periods (up to 30 days 1 month). As a result of this the production of biogas was remarkably enhanced by these two experimental bacterial enhancers than the control. While, the vegetable wastes subjected with the addition of *Lactobacillus* sp., showed the maximum production 96% on second day itself, followed by another higher production was observed fruit waste and cowdung. From the present result clearly showed that the *Lactobacillus* can be uses as a better enhancer for more biogas production with short term of period compared with control condition, though other tested organism of *E. coli* also act as a modest range enhancer of biogas production. Hence, the present study was concluded when utilizing or additives of these two bacterial strains in the experimental wastes for biogas production it might be enhanced the tremendous biogas production takes place within short period of time.

Introduction

Agro-waste is a specific type of biomass produced as by-product from agriculture. Agro-waste includes several types of materials like straw - rice, wheat, barley, oat, corn cobs, cotton and maize stover, rice husk etc., and is based on annual plants (Nagamany and Ramasamy, 1999; Sagagi *et al.*, 2009). India produces 150 million tones of fruits and vegetables and generates 50 million tones of wastes per develop appropriate waste treatment technology for vegetable wastes to minimize green house gas emission (Chanchal and Biswas, 2012). The process of digestion and production of biogas depends on the composition of feedstock and the fermentation products of the vegetable wastes (Dhanyalakshmi *et al.*, 2012). In recent year's global energy crisis increased at a fast pace (Viswanath *et al.*, 1992; Usman *et al*., 2011). Demand for the use of fossil fuels for cooking and other commercial activities increased along with the increasing population of India. Use of renewable sources of energy viz. biogas for cooking etc can somewhat is an alternative for the excessive demand of fossil fuels like LPG (Das *et al.,* 2013). The rate of bio gas production varies with different conditions and parameters like temperature, stirring speed, feed concentration, catalyst concentration, etc. It has been found that the catalyst mainly increases the production rate of biogas from water hyacinth (Sridevi and Ramanujam, 2012). Performance of the reactors was evaluated by estimating destruction of Total and Volatile Solids and by monitoring daily gas production. The performance evaluation in terms of specific gas production based on amount of total solids added and volatile solids added has indicated that the mixture of vegetable wastes chosen for the study are amenable to anaerobic digestion (Nagle *et al*., 2011). Flammable biogas production of brewery spent grain could be enhanced significantly in the presence of cow liquor waste. Previously, Viturtia *et al*., 1989 studied the fruit and vegetable wastes are produced in large quantities in markets and constitute a source nuisance in municipal landfills because of their highr, however the increased prices of oil and increased awareness of climate change will trigger the increasing use of renewable energy, such as biogas (Mattsson *et al.,* 2011)**.** Vegetable wastes were an-aerobically digested in a fed-batch laboratory scale reactor at mesophilic conditions (35^{o}C). The physicochemical parameters of the wastes were determined including microbial analysis. It also indicates that blending paper waste with cow dung or any other animal waste will give sustained gas flammability throughout the digestion period of the waste since animal wastes are good starters for poor biogas producing wastes (Ofoefule *et al***.,** 2010). The percent methane content of the biogas in all the treatments whereas, found on par with Cattle dung (Nnabuchi *et al*., 2012; Nitin *et al.*, 2012). Organic compounds decompose under anaerobic condition to yield biogas. Still, there is no other research has been done in this similar kind of experiment. Since, the present study was planned the following kinds of objectives; like that to investigate the biogas production potentials of vegetable waste, fruit waste and cow dung, along with an examined the enhanced or improved the production biogas using microbial cultures as well as natural enhancer of Parthenium.

Materials and Methods

Sample collection and processing

The cow dung was collected in a sterile polythene bag from houses. The collected samples were grinded and sterilized before fermentation. The sterilized substance should be mixed with distilled water in 1:1 ratio.

Design of invitro anaerobic digester

The invitro anaerobic digester, 2.25 litre reactor was filled with grinded substrate. An inlet slit was made on the top of the reactor and connected with a balloon were the generated gas were collected. The collected gases were used for further analysis.

Isolation and Identification of *E. coli* and *Lactobacillus* as enhancers

The *E.coli* and *Lactobacillus* were isolated and identified of through Bergey's manual. The isolated organisms were purified and used as biological enhancers for biogas production.

Small scale production of bio-methanation

1kg of each vegetable waste, fruit waste and cow dung were taken and homogenized and mixed with 1 litre of distilled water in the ratio 1:1. Then the mixture was inoculated with 20 ml of starter culture (Methanogenic bacteria) as control and addition of 5 ml enhancers (*Lactobacillus* and *E. coli* culture) were added as test and the digester was allowed to incubate at various temperatures in anaerobic condition.

Biochemical process of anaerobic digestion

Anaerobic digestion (AD) is a microbiological process of decomposition of organic matter in the absence of oxygen. Specific groups of micro-organisms are involved in each individual step. These organisms successively decompose the products of the previous steps. There are four steps namely hydrolysis, Acidogenesis, acetogenesis and methanogenesis.

Hydrolysis

Hydrolysis is theoretically the first step of AD, during which the complex organic matter (polymers) is decomposed into smaller units (mono and oligomers). During hydrolysis, polymers like carbohydrates, lipids, nucleic acids and proteins are converted into glucose, glycerol, purines and pyrimidines.

Acidogenesis

During acidogenesis, the products of hydrolysis are converted by acidogeneic (fermentative) bacteria into methanogenic substrates. Simple sugars, amino acids and fatty acids are degraded into acetate, carbon dioxide and hydrogen (70%) as well as into volatile fatty acids (VFA) and alcohols (30%).

Acetogenesis

Products from acidogenesis, which cannot be directly converted to methane by methanogenic bacteria, are converted into methanogenic substrates during acetogenesis.

Methanogenesis

The production of methane and carbon dioxide from intermediate products is carried out by Methanogenic bacteria.

Results and Discussion

When the three kind of experimental wastes treated with (anaerobic condition) three different enhancers such as *Lactobacillus, E.coli* and Parthenium. As a result of this, maximum biogas production takes place on vegetable wastes with *lactobacillus* treatment (Figure-1). Furthermore, secondly maximum production was observed in the fruit waste exposed with the similar bacteria. But when the cowdung sample treated with the *lactobacillus* enhancer showed no production. Moreover, the second type of enhancer (*E.coli*) treated sample maximum and minimum biogas production was observed on vegetable and fruit wastes 90% and 85% respectively (Fig. 1).

Subsequently, cowdung sample didn't given any other biogas production when incubated with *E. coli* bacteria. Though, the third enhancer of Parthenium subjected experimental wastes first two samples had no effective production but third cowdung sample could be produced maximum biogas.

From the overall result showed that these three experimental wastes incubated with the three enhancers or without enhancer(s) interestingly from the vegetable wastes, biogas production was started second day itself from the stipulated period of time. This was very clearly depicted that very short term period of production takes place in vegetable waste alone than other two experimental wastes (Fig;2-4). Moreover, Parthenium is a natural enhancer for biogas production but the present study showed that the similar enhancer wasn't any effective enhancing production occurred when it combined with agronomic vegetable and fruit wastes.

Fruit and Vegetable Wastes (FVW) are produced in large quantities in markets, and constitute a source of nuisance in municipal landfills because of their high biodegradability. In the present study, the result showed that the vegetable waste produce high amount of gas when compared to fruit and cow dung (Hansen *et al*., 2004; Ojolo *et al.,* (2008) reported on comparative analysis of utilization of poultry, cow and kitchen waste for biogas production and the analytical approach for predicting biogas generation in a municipal solid waste anaerobic digester respectively Adeyosoye *et al.*(2010) estimated the proximate composition and biogas production from invitro gas fermentation of sweet potato and wild cocoa yam peels. Therefore this work was focused principally on the production of biogas from domestic wastes. This shows that carbohydrates have been broken down much faster than the proteins and fats present in the wastes and produced the gas. Waste degradation which was advantageous to the environment was also achieved in the process, thus disposal problems of wastes can be solved alongside energy generation. Ukpai *et al*., 2012 estimated the comparative study of biogas production from cow dung, cow pea and cassava peeling using 45 liters biogas digester. The result showed that cow pea produced the highest methane content of 76.2%, followed by cow dung with 67.9 % methane content and cassava peeling has the least methane content of 51.4%. Cow pea was favored in terms of volume of flammable biogas production of biogas and flamed on the 7th day reported by Gupta *et al*. (2009).

From this present work, it showed that the microbial cultures have the ability to enhance the production of biogas it was already been conformed by Gunaseelan, (1987). Furthermore, it was revealed that the Parthenium can be used as addictives with cattle manure in biogas production (Das and Mondal, 2013) suggested that the methanogenesis from cow dung and poultry litter waste digesters can be improved by the addition of iron. Recently, Antony Raja *et al*., (2012) explained that addition of wood charcoal with water hyacinth enhances the bio gas yield. But water hyacinth and cow dung mixture yield more biogas than water hyacinth and wood charcoal mixture because the cow dung generates more methane gas.

Neves *et al*., (2005) two different approaches were attempted to try and enhance methane production from an industrial waste composed of 100%

Figure.1 Assessment of biogas production from the three different wastes with three enhancers (microbial and chemical)

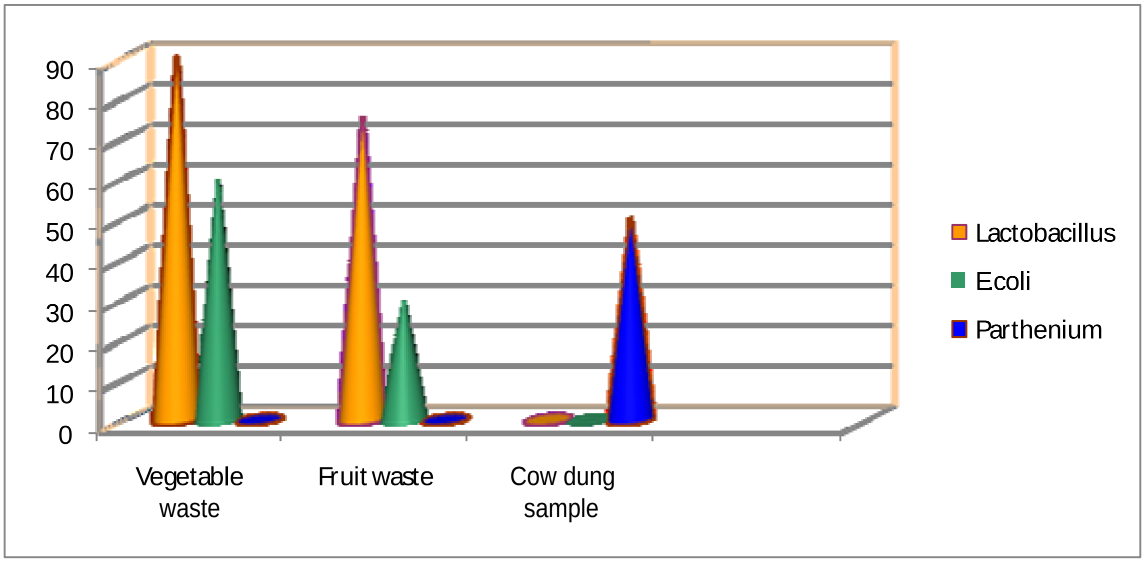


Figure.2 Influence of anerobic organism and it enhancing activity for Biogas production In Vegetable Waste On 2nd Day incubation

Before Enhancement

after Enhancement with *E. coli*

Before Enhancement

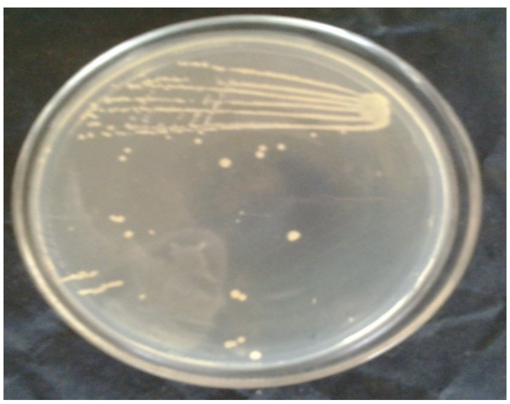
After Enhancement *Lactobacillus*)

Figure.3 Biogas Production of Before Enhancement (A) and After Enhancement (B) *Lactobacillus*) From Fruit Wastes On 2nd Day of the experiment

(A) Before Enhancement

(B) After Enhancement

Figure.4 Assertion of *Lactobacillus sp* on (A) MRS medium (B) *E.coli* on EMB Agar for the treatment of enhancers for biogas production



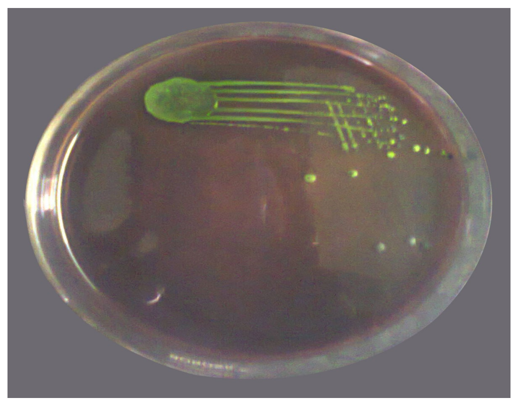


Figure.4 Biochemical test for *Lactobacillus sp* (A) and *E.coli* (B)

(A) **(B)**

barley, which results from production of instant coffee substitutes. The second approach, followed in the present work, consisted of co-digestion with kitchen waste (40BW, 60 kitchen wastes). The present work also agreed by several researchers with the production of biogas from the different types of source material (Hansen *et al*., 2004; Carrère *et al*., 2010; Ofoefule *et al*., (2010) have shown that paper waste which abound everywhere including the immediate environment is a very good feedstock for biogas production. The study has also shown that blending the paper waste with cow dung or any other animal waste will give sustained gas flammability throughout the digestion period of the waste Antony and Lindon, (2012). Since animal wastes are good starters for poor producing wastes. Moreover, the enhancers like microorganisms especially bacteria strains that take part in the anaerobic digestion process are particularly sensitive to the pH (Cheerawit *et al*., 2011; Thaniya and Sohgrathok, 2012). For this reason when the pH in the system is far from the pH interval. In past as well as recently the present result also been highlighted with the following author's by Rantala *et al*. (1994; Giovanni *et al*. (2012) the biomethanation rate is lower than expected. The characteristics of anaerobically digested fluid and digester performance in terms of biogas production effectively from the different sample sources such as fruit (Sagagi *et al*., 2009) and vegetable wastes, cowdung (Osueke *et al*., 2013) mango, pineapple, tomato, jackfruit, banana and orange, it will mainly determined by the biotic and abiotic factors opined by Prema *et al*. (1992); Baba and Nasir, (2012).

Several sources of energy exist in nature; it is coal, electricity and fossil oil which have been commercially exploited for many useful purposes. This century has witnessed the phenomenal growth of various industries based on these energy sources. They have application (Bouallagui *et al*., 2009).

in agricultural farms and have domestic use in one form or other. Biogas technology provides an alternate source of energy in rural India, and is hailed as an archetypal appropriate technology that meets the basic need for cooking fuel in rural areas. Using local resources, viz. cattle waste, manure, sewage, municipal waste, plant material, and crops are derived. Vegetable waste is an organic material having the high calorific value and nutritive value to microbes, that's why efficiency of methane production can be increased by several orders of magnitude. It means higher efficiency and size of reactor and cost of biogas production is reduced. Also in most of cities and places, vegetable waste is disposed in landfill or discarded which causes the public health hazards. Inadequate management of wastes like uncontrolled dumping bears several adverse consequences such as it emits unpleasant odour and methane which is a major greenhouse gas contributing to global warming. Biogas is produced by bacteria through the bio-degradation of organic material under anaerobic conditions. Natural generation of biogas is an important part of bio-geochemical carbon cycle. It can be used both in rural and urban areas.

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