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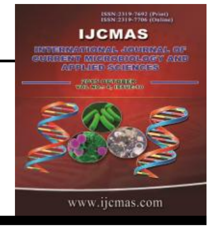

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Original Research Article

Role of Coconut Water on Microbial Population of Anaerobic Digester

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Keywords

Anaerobic digester, Coconut water, Microbes etc

A B S T R A C T

Anaerobic digestion is a microbial process. A wide variety of microbes are involved in the breakdown of materials in anaerobic digesters. The digester performance mainly depends upon the type and number of microbial population in digests. In this present investigation an attempt was made to study the "Role of coconut water on microbial population of biogas digester". Various amounts (50ml, 100ml, 150ml) of coconut water supplemented in batch anaerobic (bio-gas) digester revealed that the digester added to 100 ml of coconut water showed better performance than the other two digests. Analysis of microbial population indicates that the microbial number sharply increased with the amount of the coconut water addition. On the basis of the above observation, it can be concluded that the optimum amount of coconut water can be supplemented in biogas digested in order to achieve better digester performance.

Introduction

Anaerobic digestion of organic materials for methane production is a microbial process. There are three groups of microorganisms involved in anaerobic digestion. They are fermentative prokaryotes, which produced mainly short chain organic acids, CO_2 and H_2 from the organic waste materials, the second group of prokaryotes, Acetogenic, which oxidize these organic acids and other compounds such as lactate and ethanol to acetate CO_2 and H_2 and the third group, Methanogenic prokaryotes which utilize CO_2, H_2 and acetate to produce methane. The methanogens *(Archae)* are obligate anaerobes that are slow growers (doubling time of certain species are 9 days) and therefore represent the rate limiting step in the anaerobic digestion of organic waste (Daniel Lim, 1998).

The coconut palm *(Cocos nucifera)* is a tropical tree that is cultivated in nearly 90 different countries (Pires, *et al.*, 2004). An immature coconut between six to nine months, contains about 750 ml of water that eventually becomes the flesh (FAO, 2005). Coconut water is not only a tropical beverage, but also a traditional medicine (Ediriweera, 2003) a microbiological growth medium (Osazuwa, *et al.*, 1989) and a ceremonial gift (Rethinam, *et al.* 2001) and can be processed into vinegar (Sanchez, *et al.*, 1985) or wine (Augustine, *et al.*, 2007). These various uses are possible thanks to the original biochemical composition of the juice. The particular mineral composition and reasonable total sugar content make coconut water a natural isotonic liquid. The characteristics of coconut water make it an ideal rehydrating and refreshing drink after physical exercise (Saat, *et al.*, 2002).

This present investigation deals with the effect of coconut water on microbial population of anaerobic digester and digester performance (bio-gas production).

Materials and Methods

The whole experiment was carried out in two different phases with laboratory scale batch digesters. In the first phase, various amounts of coconut water (50ml, 100ml, 150ml) were supplemented with slurries prepared by mixing sewage sludge, raw sewage and cow dung as shown below.

In the second phase of the experiment a known amount of coconut water (100ml) was supplemented with biogas slurry prepared by mixing seaweed (agar industry waste) cow dung and tap water as follows.

One lit. Of each slurry was taken in separate digests and were maintained at room temperature for 25 days. Gas measurement was made by the water displacement method, Once in a day.

Parameters studied

First phase of experiment

Total gas production
Physico-chemical parameters of bio gas slurries
Total microbial population in digesting slurries.
Methane Content of bio-gas

Second phase of experiment

Total gas production
Total microbial population in the initial phase of digestion (first 5 days)
Gas burning test.
A total Microbial analysis was made by a candle jar method

Results and Discussion

The results of the first phase of experiment recorded in the Table.3 revealed that biogas production was increased in T_1 and T_2 digests than control digests. However, maximum biogas yield was recorded in the T_2 digester, whereas gas production was slightly decreased in T_3 digesters than in control Fig.1.

The analysis of total microbes of the digested slurries revealed that the microbial population sharply increased in all digesters than in control. The rate of increase was directly proportional to the amount of coconut water added with digesters.

The results of the second phase of experiments recorded in Table.4. The table reveals that the coconut water supplemented digests have better performance in total biogas yield as well as the gas production was started in 2nd day of digestion and burnable gas produced on the 18th day whereas, it was in 7th and 20th day respectively in the control digests. The total microbial population of treatment digesters was also superior than the control Fig.2.

Coconut water is widely used in the plant tissue culture industry, growing fungus and other microbes (Renato, *et al.*, 2009; Verdeil, *et al.*, 2002; Ang and Yong, 2005 and Arditti, 2008).

Table.1 Biogas slurry preparation

S/No	Substrate (gm)		Solvent(ml)		Designation of Digesters
	Sewage sludge	Cow dung	Raw Sludge	Coconut water	
1	120	480	600	--	Control
2	120	480	550	50	T1
3	120	480	500	100	T2
4	120	480	450	150	T3

Table.2 Biogas slurry preparation

S/No	Substrate (gm)		Solvent (ml)		Designation of Digesters
	*Sea weed	Cow dung	Tap water	Coconut water	
1	300	300	700	--	Control
2	300	300	600	100	T4

Keys: * Pre Treated

Table.3 Effect of coconut water (Various concentrations) on biogas yield and total microbial population of digested slurry

S/No.	Treatments	Total biogas yield in 25 days (lit)	Average gas yield per day (Lit)	% of biogas yield increase and decrease over control	Total no.of bacterial colonies in the digested slurry (No.of colony/gm of sample
1	Control	7.328	0.293	--	170X10-4
2	T1	8.105	0.342	10.60	260X10-4
3	T2	9.030	0.361	23.20	330X10-4
4	T3	7.320	0.292	-0.10	460X10-4

Keys: (+) Increase; (-) Decrease

Table.4 Total Biogas production over the period of 25 days

S/No.	Slurry type	Total bio gas yield 25 days in cc	Burnable gas formed on (day)
1	Control	2155.0	20th
2	Treatment (Coconut water	2723.0	18th

Fig.1 Pattern of biogas yield in coconut water supplemented digests

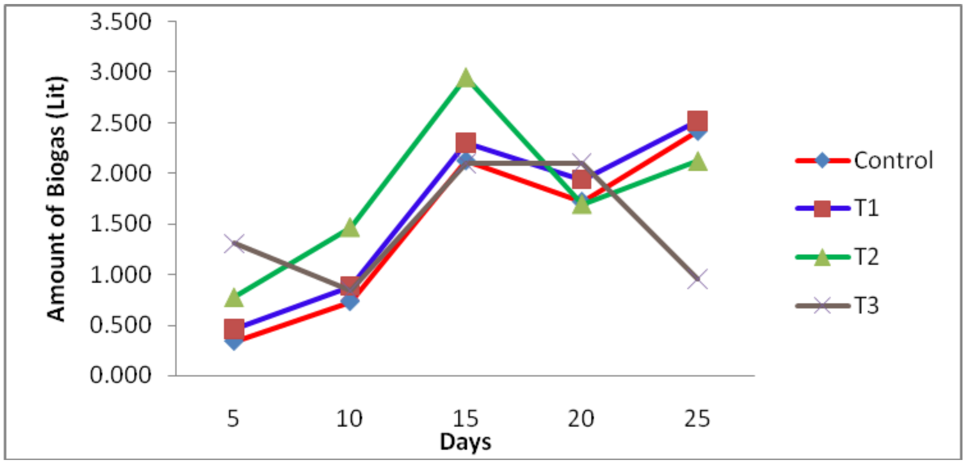
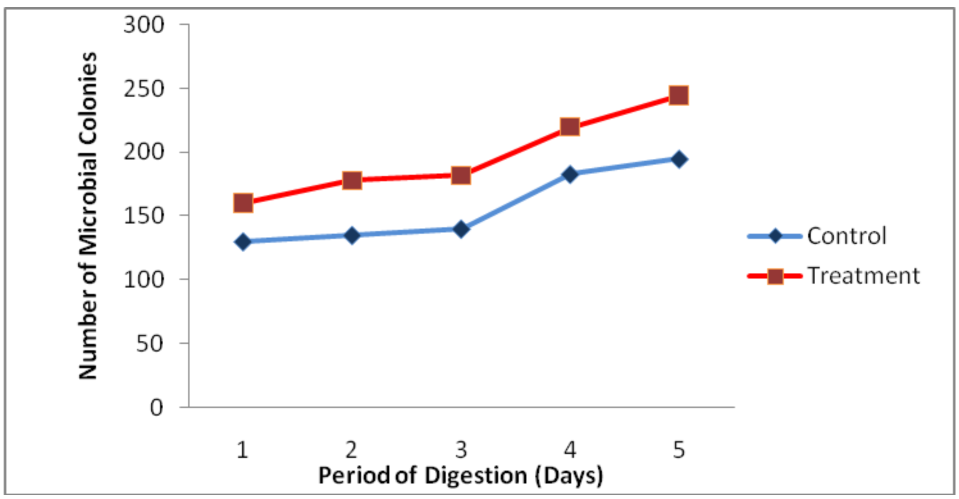


Fig.2 Total microbial count in earlier phase of digestion



The extensive use of coconut water as a growth- promoting component in the tissue culture medium formulation can be traced back to more than half a century ago, when (Overbeek, *et al.*, 1947) first introduced coconut water as a new component of the nutrient medium for callus cultures. In few such studies, coconut water was used as a complete medium for microbial growth (Oloke and Glick, 2006). Demonstrated the supplementation of coconut water to yeast extract-diluted seawater medium for the production of docosahexaenoic acid (DHA), which was 50% higher than that of non-supplemented media (Unagul, *et al*. 2007).

Supplementation of various amounts of coconut water in anaerobic digesters improved the overall digester performance up to a certain concentration (lower concentration) whereas it had negative effect on digester performance after a certain level (higher concentration). It was reported by several workers that the digester performance was control due to a variety of parameters such pH, reduction of total solids, volatile solids, (Horton and hawker, 1981).

However, the overall conversion of the organic matter into fuel in anaerobic digesters mainly depends upon the quality and quantity of microbial populations. The superior performance of T1, T2 digesters and elevated microbial number in the digested slurries than control may be due to the addition of coconut water. The hormones and minerals which are present in the coconut water have an influence on microbial quantity and their activities.

Liu-Ke-Xin and Chen Gang Quan (1981) have reported that the accumulation of more acidic acid in the digester inhibited the activity of methane producing bacteria strongly and result in poor gas yield. It was also reported that the enrichment of minor elements and some hormones in the bacterial medium, enhance the fermentation in the initial stage of biogas production (Lyamachai and Bhatia,1981).

The poor total biogas yield in the T3 digesters than all other digesters may be due to a quick increase of fermentative bacteria in the earlier phase of the digestion resulting in an accumulation of more organic acid in the digesters. This accumulation in turn inhibits the multiplication and activities of methanogenic bacteria in the later phase. Increased biogas yield in the initial phase of digestion and maximum number of microbial population in the digested slurry of T3 digesters supports the above possibility.

Results and observation of the experiments in the second phase, almost confirm the results of the first phase.

In conclusion, on the basis of the above results it can be concluded that coconut water can be supplemented in optimum level in order to enhance the quantity and quality of the anaerobes, to achieve better performance of the digesters.

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