



Research Paper

CO-DIGESTION OF POTATO AND ONION MARKET WASTE FOR BIOGAS GENERATION

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Abstract

Potato and onion markets generate huge quantities of wastes. Present inappropriate disposal methods results in environment pollution and hazards to human health. Biomethanation is the anaerobic digestion of biodegradable organic waste under controlled conditions of temperature, moisture and pH in an enclosed space to generate biogas comprising mainly methane and carbon dioxide. Biomethanation appears to be an attractive option for the treatment of potato-onion waste since it converts waste into renewable source of energy and natural fertilizer. The objectives of the present study was to investigate biomethanation potential of potato and onion waste in co-digestion manner in terms of biogas yield and the volatile solids removal efficiency by conducting a lab scale study under ambient temperature conditions. The average daily biogas yield obtained in co-digestion ranged from 0.439 L/gm VS added to 0.481 L/gm VS added. The highest average daily biogas yield was exhibited by digester fed with 100% potato waste. The lowest average daily biogas yield was exhibited by digester fed with the admixture of 25% potato waste and 75% onion waste. Maximum total solids, volatile solids, biochemical oxygen demand and chemical oxygen demand reduction was exhibited by digester fed with 100% potato waste. In conclusion, it was found that potato waste alone had a strong biomethanation potential instead of combination with onion waste.

Key words: Co-digestion, environmental pollution, biomethanation, renewable energy, biogas yield, etc.

INTRODUCTION

Several cities have separate potato and onion markets and serve as a source of potato and onion waste. Potato and onion waste also represents the largest share of vegetable wastes. It is produced in large quantities due to poor and inadequate transportation, storage facilities and marketing practices. They have high moisture content and thus are perishable in nature ^[1].

The collection, transportation and disposal of potato and onion waste is a very serious problem today. The present vegetable waste management systems includes disposal by dumping in municipal landfills, spreading on land and by feeding to animals. These inappropriate treatment methods results in land, water and air pollution and also cause hazards to human health ^[2,3,4,5,6].

Hence, there has been a strong need for eco-friendly waste management systems. The biological treatment of these wastes appears to be most cost effective [7]. Thus, the objectives of this study was to investigate biogas yield and total volatile solids reduction during the co-digestion of potato and onion market waste by conducting laboratory scale study at ambient temperature conditions.

MATERIALS AND METHODS:

MATERIALS:

1. Potato waste and onion waste
2. Inoculum from cattle dung based biomethanation plant
3. 1 L capacity biogas digester (KVIC design of floating dome type)
4. Combustibility testing assembly
5. Gas measurement assembly
6. Gas chromatography assembly

METHODS:

1. Collections and preparations of samples:

The waste for the present study were collected from the local potato-onion market and transported to laboratory in polyethylene bags. The collected wastes were further segregated into potato and onion waste types. The equal proportions of these individual wastes were mixed in the laboratory, shredded and ground in a kitchen blender and used as feed to the reactor and kept in refrigerator at 4°C until used. The physico-chemical characteristics of the substrate were determined as per the standard methods [8].

2. Preperation of inoculums:

Inoculum was obtained from an active mesophilic digester of cattle dung based biomethanation plant located at Degaon village, M.I.D.C., Satara (M.S.), India. The physico-chemical characteristics of the inoculum were determined as per standard methods [8].

3. Experimental design:

Biomethanation studies were carried out in a floating dome design type of 1 liter capacity laboratory scale constructed reactors. The reactors were provided with suitable arrangements for feeding, gas collection and draining of residues. The effective volume of each of the reactor was maintained at 600 ml by diluting 200 ml inoculum with 400 ml tap water. Acclimatization of inoculums was done before initiation of the experiment. The reactors were operated in continuous mode with daily feeding of respective waste slurry. The reactors were mixed manually by means of shaking and swirling once in a day to break the scum.

Co-digestion of potato waste and Onion waste for biogas generation:

Potato and onion waste were mixed in various proportions to feed into different digesters. Total of five digesters were used in experiment. The digesters and their contents were as follows:

- Digester A: fed with 100% potato waste
- Digester B: fed with admixture of 75% potato waste and 25% onion waste
- Digester C: fed with admixture of 50% potato waste and 50% onion waste
- Digester D: fed with admixture of 25% potato waste and 75% onion waste
- Digester E: fed with 100% onion waste

The experiment was carried out at 20 days HRT, pH 7.0 of the substrate and ambient temperature conditions. The daily biogas yield was recorded for all these combinations.

4. Analytical methods:

The physico-chemical analysis of substrate, inoculums and effluent were determined according to Standard Methods [8]. Biogas production from the reactors was monitored at a fixed time each day by water displacement method. The volume of water displaced from the glass beaker was equivalent to the volume of gas generated. Analysis of biogas was carried on Michro 9100 Gas chromatograph by using TCD and nitrogen as carrier gas.

RESULTS AND DISCUSSION:

The results of physico-chemical analysis of substrate used for biomethanation studies are represented in Table 1.

The physico-chemical characteristics of the inoculum are represented in Table 2.

The daily biogas yield obtained from co-digestion of Potato and Onion waste in terms of volume is represented in Fig. 1. The highest daily biogas yield was produced by a digester fed with 100% potato waste. Maximum biogas was produced on 8th day as 483 ml. The lowest daily biogas yield was produced by a digester fed with 100% onion waste. The volume of biogas produced in 20 days experiment by digesters A, B, C, D and E was 7746ml, 5824ml, 4962ml, 4474ml and 4266ml respectively.

The average daily biogas yield obtained from co-digestion of Potato and Onion waste in terms of gm VS added are represented in Fig.2. The highest biogas yield (0.711L/gm VS added) was exhibited by the digester fed with 100% potato waste. The lowest average daily biogas yield (0.439L/gm VS added) was exhibited by digester fed with the mixture of 25% potato waste and 75% onion waste. Highest total solids (TS), volatile solids (VS), biochemical oxygen demand (BOD) and chemical oxygen demand (COD) reduction was exhibited by a digester A (fed with 100% potato waste) which was found to be 83.5%, 87.5%, 88.41% and 83.78% respectively. The methane content in biogas obtained from digester A was found to be 60 %.

The biogas yields obtained from potato wastes in the present study are comparatively higher than reported by previous researchers. Gunaseelan et al reported 0.267L/gm VS biogas with 90.9% VS reduction from rotten Potato waste [9]. Lane reported biogas yield as 0.426 L/gm VS added from Potato waste [10].

The high and low biogas yields from potato and onion waste respectively could be related to their chemical composition and nutritive values [11]. Onion Seed oils are rich in antibacterial bioactive constituents and thus reduce the biogas yield during co-digestion with potato waste.

Table 1: Physico-chemical analysis of substrate:

Sr. No.	Parameter	Unit	Potato waste	Onion waste
1.	pH	-	6.49	5.18
2.	Moisture	%	83.74	86.76
3.	Carbohydrates	%	11.80	8.52
4.	Dietary fiber	%	0.67	0.98
5.	Crude protein	%	2.88	3.14
6.	Fat	%	0.07	0.13

Table 2 : Physico-chemical analysis of inoculum:

Sr.No.	Parameter	Unit	Value
1.	pH	-	6.25
2.	BOD 5 days at 20°C	(mg/l)	7980
3.	COD	(mg/l)	16800
4.	Total solids	(mg/l)	15160
5.	Total volatile solids	(mg/l)	10260
6.	Total dissolved solids	(mg/l)	1480

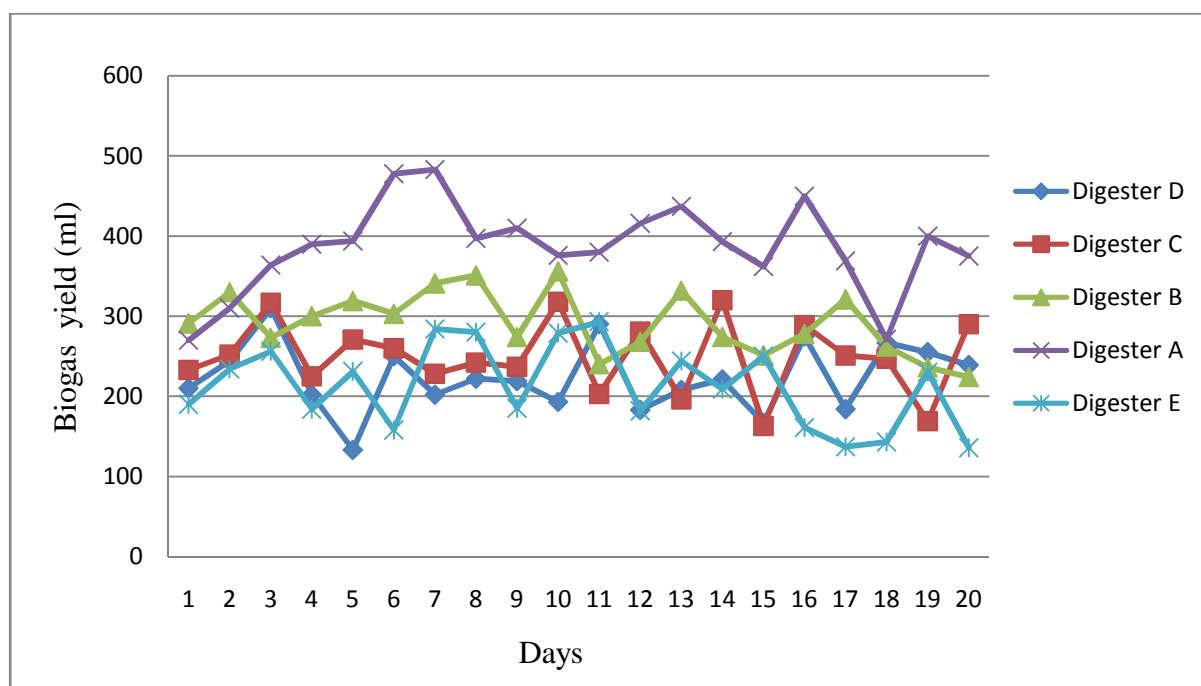


Fig.1: Daily biogas yield (ml) from co-digestion of potato and onion waste.

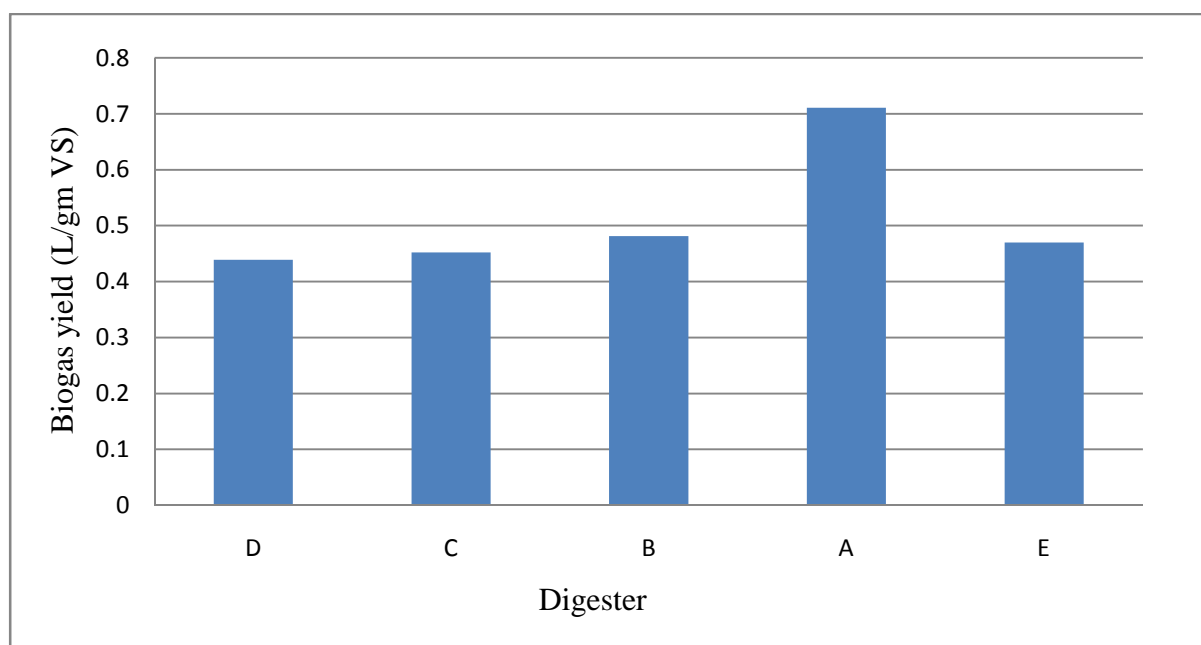


Fig.2: Average daily biogas yield (L/gm VS) from co-digestion of potato and onion waste in 20 days.

CONCLUSION:

1. The co-digestion study of potato and onion waste has been carried out in a laboratory scale capacity floating dome design type of reactor for 20 days.
2. The highest average daily biogas yield (0.711L/gm VS added) was exhibited by the digester fed with 100% potato waste.
3. The average daily biogas yield from admixture of 75% potato waste and 25% onion waste was found to be 0.481 L/gm VS added.
4. The average daily biogas yield from admixture of 50% potato waste and 50% onion waste was found to be 0.452 L/gm VS added.

5. The average daily biogas yield from 100% onion waste was found to be 0.470 L/gm VS added.
6. The lowest average daily biogas yield (0.439L/gm VS added) was exhibited by digester fed with the mixture of 25% potato waste and 75% onion waste.
7. The highest TS, VS, BOD and COD removal efficiency was found to be associated with digester fed with 100% potato waste.
8. Onion waste alone and mixture of onion waste with potato waste exhibited the low yield as compared to potato waste alone as the onion waste contained antibacterial bioactive constituents.
9. From the present co-digestion study, it can be concluded that the potato waste alone have a strong biomethanation potential.

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