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Enhancement of Methane Production from Tea Waste and Pumpkin Waste using Human Urine

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***Abstract*- Biogas is an alternate source of energy in rural areas and this biogas can be produced from food or agricultural wastes. Huge amount of tea waste is wasting from tea shop and pumpkins from the market. Human urine is unhygienic to the open environment, whereas it can be utilized as a biocatalyst for the enhancement of production of biogas from these wastes. In this study predigested tea and pumpkin wastes were treated with human urine to enhance the biogas production by improving the C:N ratio. Maximum amount of methane was obtained from pumpkin than tea waste due to higher percentage of carbon. Maximum CH_4 yield (263 ml) was observed in case of pumpkin waste (100 g) by adding 150 ml of urine.**

***Index Terms*- Biogas, Human urine, Methane, Pumpkin waste, Tea waste, Waste management**

1. INTRODUCTION

India is an agricultural based country. Huge amount of vegetable and other organic wastes pollute the environment due to formation of natural and marsh gas known as green house gas having greater global warming potential [1,2]. However, this biogas is the only cheap alternative renewable source of energy. It is composed mainly of CH_4 and CO_2 [3]. Methane has potential uses viz. as fuel, electricity generation, urea production etc [4,5]. Anaerobic digestion is the process which breaks down organic matter to simple chemical component using four different stages [6,7,8,9]. These are hydrolysis, acidogenesis, acitogenesis and methanogenesis. In the fourth stage acetate is converted to CH_4 and CO_2 [10,11,12]. Various works have been done by using agricultural and animal wastes to produce biogas [13,14,15]. Anaerobic digestion of food waste to enhance biogas was done by Dearman and Bentham [16]. In maximum cases cattle dung was using for generating biogas. However, potential source of methane from different organic waste and there C:N ratio was presented by Pound et al. [17]. Ramchandra et al. [18] revealed that studies on chemical changes and different groups of micro organisms are needed to be understood for better control of anaerobic process.

India is the largest producer and consumer of tea in the world [19]. Disposal of tea waste to the environment creates environmental pollution [20]. Tea waste can be utilized for the production of methane gas [21]. Many vegetable wastes like pumpkin is polluting environment [22]; however, this pumpkin waste can be used for biogas production. Human urine is also unhygienic to open environment where as, it can be act as a potential biocatalyst during biogas production. However, only one work has been reported to produce biogas from organic wastes by utilizing human urine [23].

So, the objective of the present work was to enhance the production of biogas from tea waste and pumpkin waste by predigesting with water followed by anaerobic digestion of the mixture using different levels of urine as a biocatalyst.

2. MATERIALS AND METHODS

The proximate composition of tea waste and pumpkin waste was determined by the method suggested by Rangana [24]. Tea and pumpkin (without seed) wastes (each 100 g) were predigested separately by keeping cover for 12 days. The predigested wastes were introduced into the digester (a conical glass beaker, 500 ml capacity; Fig. 1) separately. Anaerobic digestion was performed by adding 3 different levels of human urine (120 ml, 150 ml and 200 ml) for each waste at 30°C. The gas generated in the digester was passed through a pipe to the gas burette and collected in the burette by downward displacement of water [25]. Gas production was calculated from daily reading of the gas burette.

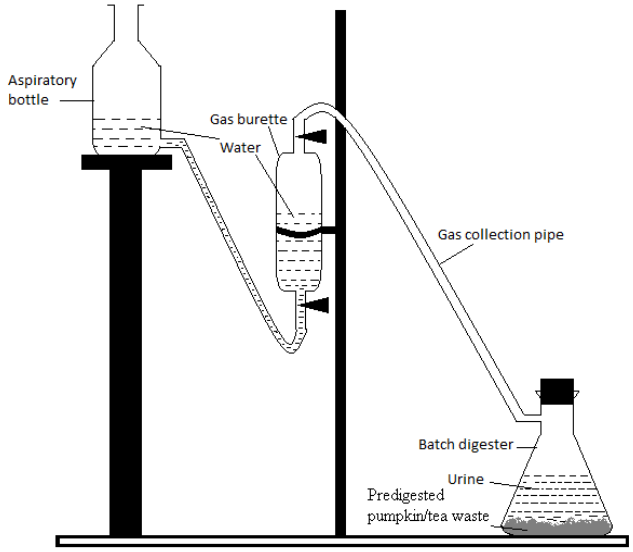


Fig. 1. Schematic diagram of digester set-up for pumpkin or tea waste [26]

Syringe method [27] was used for the measurement of amount of CH_4 and CO_2 in biogas production. A syringe fitted with flexible tube and diluted NaOH solution was used for CO_2 percentage estimation since NaOH absorbs CO_2 but does not absorbs CH_4.

3. RESULTS AND DISCUSSION

Table 1 and Table 2 show the proximate chemical composition of tea waste and pumpkin waste, respectively. In our another study [26] it has been reported that the proximate nitrogen composition of human urine was total N: 2.62 g/l; NH_4^+ -N: 1.71 g/l; NH_3, aq –N: 0.75 g/l; amino acid –N: 0.12 g/l; NO_3^- –N: 46 µg/l; NO_2^- -N: 21 µg/l.

Table 1. Proximate composition of tea leaves waste

Constituents	Value
Total solids (TS)	94.3%
Volatile solides	97.9% (of TS)
C	46.7% (of TS)
N	1.5% (of TS)
C/N	31.1

Table 2. Proximate composition of pumpkin (*Cucurbitaceae maxima*)

Nutrients	g/kg of flesh
Moisture	841.2
Carbohydrate	134.1
Protein	10.3
Fat	4.3
Fiber	10.6
Ash	10.1

It was observed that in case of tea waste (Fig. 2), CH_4 production was decreased and then increased as the level of urine addition increased and the maximum CH_4 yield was observed at 200 ml urine addition. In case of pumpkin waste (Fig. 3), CH_4 production was at first slightly increased followed by sharp decrease as the level of urine addition increased. Comparing CH_4 yield maximum methane production (263 ml) was observed in case of pumpkin waste (100 g) by adding 150 ml of urine between both wastes.

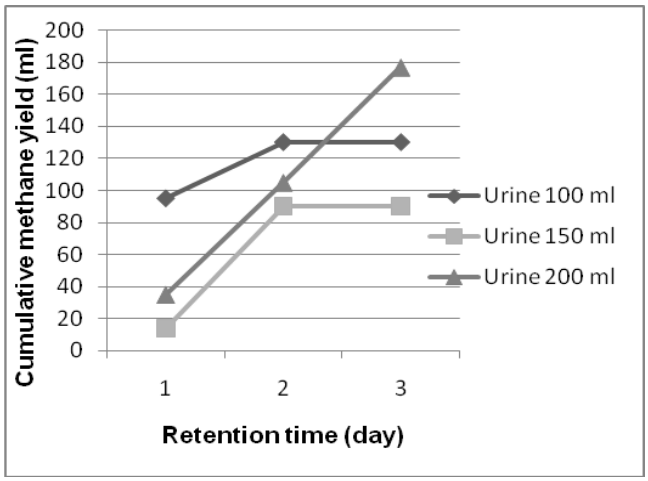


Fig. 2. Cumulative CH_4 yield (ml) against retention time (day) at different levels of urine from tea waste

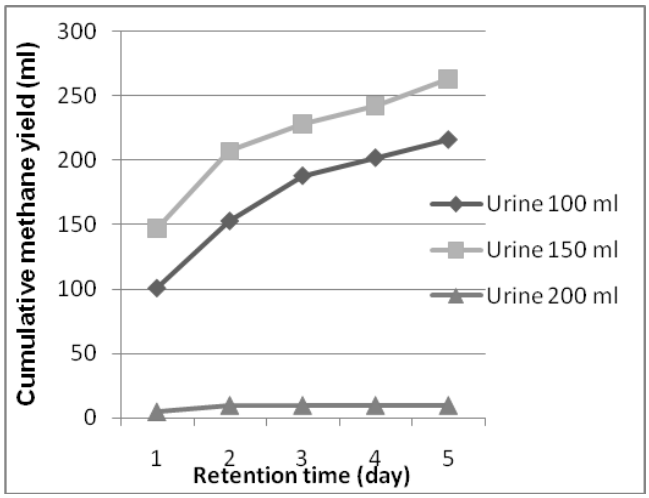


Fig. 3. Cumulative CH_4 yield (ml) against retention time (day) at different levels of urine from pumpkin waste

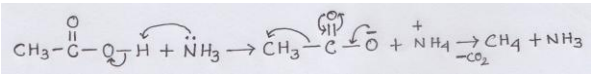
These facts were due to more appropriate C:N ratio and more balanced nutrients for the anaerobic micro organisms of biomethanation. Table 1 shows that tea waste has very high C:N ratio (31.1) and Table 2 shows that pumpkin has high percentage of carbohydrate (134.1%) whereas, C:N ratio of urine was 4:5 [28].

The pH of both tea and pumpkin wastes were decreased after pre-digestion. The acidity was well balanced and acted as buffer by the addition of human urine. pH was varied between 6.8 to 7.2. Similar observation was reported by Satyanarayana et al. [29]. The pH increased due to released of NH_4^+ ion by the deamination of amino acids and presence of NH_4^+ ion in urine. The optimum range of C:N ratio was 25±2.1 [30] for maximum yield of biogas as well as CH_4. Carbon (in carbohydrate) and nitrogen (in protein) were the main nutrients for anaerobic bacteria. Carbon supplied energies; nitrogen was needed for building up the cell structure. A too high C:N ratio means lack of nitrogen while too low value of C:N ratio leads to increase CH_4 production [31].

Anaerobic digestion was performed using human urine only, without adding tea or pumpkin waste, but no biogas was produced. So, it can be concluded that here urine acted as a biocatalyst. A similar finding was observed by Haque and Haque [23] who enhanced 30% production of biogas by addition of human urine. The possible mechanism of decarboxylation of acetic acid by human urine has been given below.

The nitrogen of amino acid is comes out as urea. This urea excreted through urine. Generally a healthy adult excreted about 15 g of nitrogen and out that of that 95%excreted through urine. The amino group of amino acid removed as ammonia which is highly toxic and converted into urea. Urine is acidic but, when it is exposed to environment it splits and ammonia released and that's why stored ammonia becomes alkaline. Ammonia functioned as a catalyst. The ammonia acts as a weak base which extract acidic H from acetic acid to form ammonia and acetate ion. The acetate ion is decarboxilated and methyl carbon ion is protonated to produce methane and ammonia [26].

$$\text{Urine} \xrightarrow{\text{deamination}} NH_4$$



Due to pH in between 6.8 to 7.2, biogas slurry which is enriched in N, P, K can be used as biofertilizer [23,32]

4. CONCLUSION

It is concluded from this study that there is a good possibility of biogas generation in biomethanation process by addition of urine as a catalyst on tea and pumpkin wastes. Maximum methane yield was obtained by addition of 150 ml and 200 ml urine on tea and pumpkin waste, respectively. Pumpkin produced more methane as compared to tea waste at similar urine level in the experiment.

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