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Evaluation of Mixing Cow Dung with Apple and Banana Peels on Biogas Yield

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Abstract: World is going to face a serious problem of energy scarcity after 100 years. The present world energy reservoirs will expire in near future. So, it is the need of hour to develop methods and technologies to get remedy of this forth coming energy crisis. The emphasis of these technologies should be on converting waste to energy. The wastes are no doubt a hidden treasure and they can be converted to wealth (energy) quite easily by applying some suitable technology. In this paper a study has been done on the anaerobic digestion of apple and banana peels for the production of biogas. Different composition of these wastes is used to produce biogas. This paper reveals the potential of Pakistani apple and banana wastes and their impact to overcome energy deficiency. At the end there is a remedial solution to the wastes of food processing industries.

Key words: Anaerobic · Apple · Banana · Energy UOG

INTRODUCTION

The main energy reservoirs of the world consist of fossil fuels like petroleum products, natural gas. These fossil fuels are not fulfilling the world energy demand but also creating environmental problems like green house gases [1]. Consequently of this increasing global temperature creating a serious threat for our earth [2], so the nations are emphasizing on renewable sources of energy.

Agricultural rich countries should focus on the energy generation from biomass feed stocks. Biomass is the most sustainable and largest resource of energy in the world. The biomass available in the world is about to be 220 billion ton (oven dry) per annum [3].

Energy generation from biomass feed stock can substitute conventional energy resources. Utilizing biomass based fuels world can reduce emission of green house gases [4]. Brazil is producing bio ethanol from sugarcane and Zimbabwe conducted a research on crop residue for energy generation. This research revealed that Zimbabwean crop residue has an energy potential to meet country's 44% gross energy demand [5]. Growcom is a Queensland based horticultural services company who used banana feed stock firstly for biogas generation [6].

Yan *et al.,* [7] calculated banana feed stock potential for power generation from banana feed stock for Malaysia. So the countries like Pakistan which is facing energy scarcity should utilize biomass resources for power generation. It has many options to be utilized to eradicate this problem.

To fulfill this alarming increase in the energy consumers and short falling of resources, Pakistan will certainly have to think over alternate measures. So a great attention should be paid to renewable sources of energy. Pakistan is an agricultural country and has a big potential of biogas generation from different types of wastes. Mittal [8] investigated that Pakistan has 1287 million tones of cattle dung annually produced. From this the estimated biogas produced is 8.58×10^{10} cubic meter. Along with this biogas 350 million tones of manure are also produced. Biogas plants are installed only in the rural areas. So far as the urban community is concerned, biogas production from fruit wastes is a better option.

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The above statistics shows a great potential of Pakistan in apple and banana production. So a study was needed to focus on the effective conversion of their wastes to energy by anaerobic digestion. Fruits are more risky to produce than other crops. The variability in yield of fruits is 2-3 times more than that in rice yield [10-12]. In Colombia, banana fruit surplus production amounts to 850.000 tons/year and it generates 1.150.000 t/year of associated residual biomass [13]. Although biogas technology has been subject to development aid and energy policy in several countries biogas only delivers small fractions of energy consumption in these countries [14-16]. Experiments have demonstrated that maize and cereals harvested at milk ripeness gain the highest yields in biogas [17]. In this work an anaerobic digestion of apple and banana peels was conducted at lab scale to observe their biogas yield.

MATERIALS AND METHODS

Pre Digestion Analysis

Analytical Methods:

The study was conducted in department of Chemical Engineering, University of Gujrat. The samples of apple and banana peels were collected from the campus fruit shop. The samples were washed and dried and then the following pre digestion analysis was conducted.

Moisture Contents: Moisture contents were determined in peels by using the laboratory oven. The samples were kept for about 2-3 hours in the oven at 110°C. The procedure was adapted from the book "standard methods 21st edition".

Volatile Solids: These were determined using FC carbolite furnace. The procedure was adapted from the book "standard methods 21st edition". The samples were kept in the furnace for about 45 minutes at 550°C.

The dried residue from total solids analysis was weighed and heated in a crucible for two hours at 500°C in a preheated furnace. After cooling the crucible and ash were weighed

$$\text{Volatile solids\%} = 100 - ((V3-V1)100/ (V2-V1))$$

where

V1 = Weight of the crucible

V2 = Weight of dry residue and crucible

V3 = Weight of ash and crucible (after cooling)

Ash Contents: It was determined by using conradson carbon residue apparatus. The samples were placed in skidmore crucible and heated for about 50 minutes.

Total Solids: The sample (approximately 10 g) was placed on a foil plate and dried to a constant weight at 105°C.

$$\text{Total solids\%} = \text{Final weight (g)} \times 100/ \text{Initial weight (g)}$$

%age of fixed carbon: it was determined by using the following formula

%age of fixed carbon= 100 – (%age of moisture +%age of VM +%age of ash)

Type of peels	Total solids%	Moisture%	Volatile solids%	Fixedsolids%
Apple	26.50	73.49	92.57	7.43
Banana	13.45	86.54	77.15	22.84

Preparation of slurry:

Slurry was prepared by using peels with different loading rates. The samples were named as A, B, C and D having different loading rates. The details of the prepared slurry samples are as follows:

Sample	Type of waste	Water (ml)	Waste (gm)
A I	Apple	350	100
A II	Apple	350	50
B I	Banana	400	50
B II	Banana	400	25

The bacteria culture was added to the slurry which was obtained from cow dung.

Experimental Design and Setup: Half liter bottles were used as digesters. A glass thermometer was inserted in each digester to measure temperature. The water displacement apparatus was used to measure the gas volume, while pH of the mixtures was measured with a digital pH meter. Weighing of the mixtures was done using a digital weighing scale. The digesters were charged once during the experiment duration for the hydraulic retention time (HRT) of 30 days with the mixture in proportions indicated in Table 1. The experiment set up is shown in Figure 1.

Table 1: Potential of Pakistan fruit production:

	Production thousand tones		Area in thousand hectares		Yield per hectares in KGs	
Year	Apple	Banana	Apple	Banana	Apple	Banana
2001-02	367.2	149.8	48.7	31.1	7540	4817
2002-03	315.4	142.9	47.7	29.7	6612	4811
2003-04	333.7	174.7	110.8	31.7	3103	5511
2004-05	351.9	148.3	111.6	32.9	3153	4508
2005-06	351.3	163.5	112.0	32.5	3137	5031
2006-07	348.4	150.5	112.7	34.9	3091	4312
2007-08	441.6	158.0	113.0	35.5	3908	4451
2008-09	441.0	157.3	113.1	36.0	3899	4369
2009-10	366.3	154.8	111.6	34.8	3282	4448

Source: Ministry of Food, Agriculture and Livestock/Federal Bureau of Statistics, Govt. of Pak., [9].

Fig. 1: Experimental setup

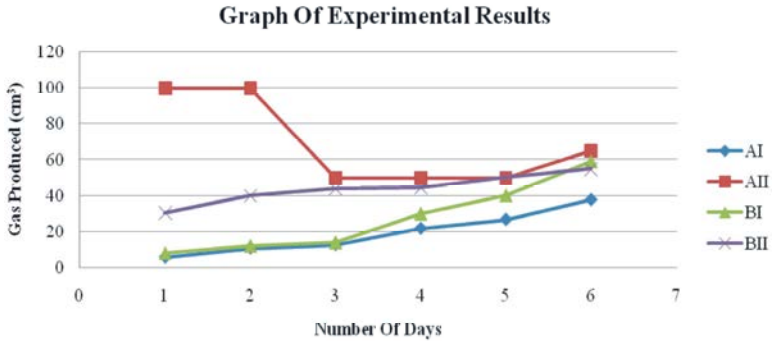

Fig. 2: Daily biogas yields of different waste samples, for a constant volume of the container

RESULTS AND DISCUSSIONS

In the Fig: 2 graphs show experimental result of selected waste samples. Experimental data tells that sample AII produced bio gas more rapidly and with greater volume.

For all the treatments, pH for the initial slurry varied within the range of 6.5 and 6.9. Thus the experiment was conducted within the pH range for optimum biogas production and there was little temperature variation effect on biogas production.

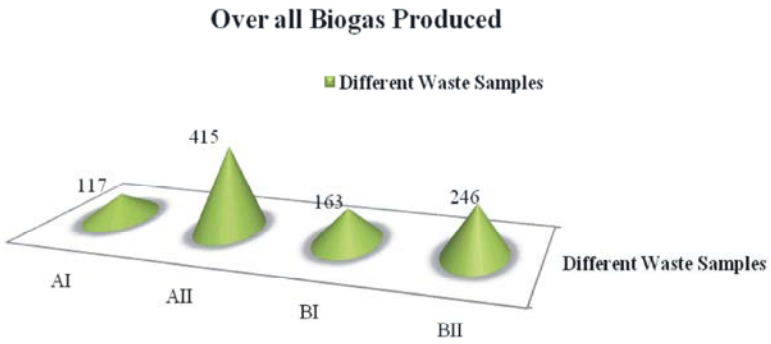

Fig. 3: Overall biogas production. So the gas produced by the sample AII i.e. (350ml water, 50mg Apple) is the greatest 415 cm^3 and the production was in the order of AII>BII>BI>AI.

From above graph (Figure 3), AII (350ml water, 50mg Apple) produced more gas per unit weight as compared to others. The higher gas yield from the sample AII could be due to a proper nutrient balance. And highest yield from sample AII was attributed to stable pH and it was hypothesized that the mixture was able to buffer itself, a pre-requisite for proper bio gas production. From the above experimentations it is obvious that apple and banana peels are quite rich in producing biogas. Since banana feed stock is quite moneyed in its bio degradable contents, so the food processing industries can get rid of their waste by installing anaerobic digestion plants. The biogas then can be further utilized for electricity generation. The electricity conversion efficiency for biogas is about 21%. This electricity can be supplied to the housing colony of the industry.

As 1m^3 of biogas can effectively run a motor of 1 hp for three hours, light a 60-100 watt bulb for 6 hours and 1.25 kWh of electricity can be generated. Along with this meal can be cooked thrice a day for a family comprising 5 to 6 members. Thus the waste can be effectively utilized for power generation to convene the household applications.

Comparing with the other samples, the maximum biogas yield was attained with the mixture AII (350ml water, 50 mg Apple) at these proportions, there was a biogas yield increase of three fold as compared to others.

REFERENCES

1. National Center for Atmospheric Research (NCAR) Climate Research. Climates of the future; 2008.
2. Solomona, S., G.K. Plattnerb, R. Knuttic and P. Friedlingsteind, 2009. Irreversible climate change due to carbon dioxide emissions. Proceedings of the National Academy of Sciences of the United States of America.
3. Demirbas, 2009. A Progress and recent trends in biodiesel fuels, Energy Conversion and Management, 50(1): 14-34.
4. Basu, P. and V. Mettanant, 2009. Biomass gasification in supercritical water—A review, International Journal of Chemical Reactor Engineering, 7: 1542-6580.
5. Jingura, R.M. and R. Matengaifa, 2008. The potential for energy production from crop Residues in Zimbabwe Biomass and Bioenergy, 32: 1287-92.
6. Patil, P.D. and S.G. Deng, 2009. Optimization of biodiesel production from edible and non-edible vegetable oils, Fuel, Elsevier Science, 88, 7: 1302-1306.
7. Yan, J.T., C.L. Lai, K.T. Lee, K.T. Tan and S. Bhatia, 2010, Banana biomass as potential renewable energy resource: A Malaysian case study Renewable and Sustainable Energy Reviews.
8. Mittal, K.M., 1996. Biogas Systems-Principal and Applications. New Age International Private Limited Publications, New Delhi.
9. Government of Pakistan, 2011. Agricultural Statistics of Pakistan (various issues). Economic Wing, Ministry of Food, Agriculture and Livestock, Islamabad.
10. Elias, S.M. and M.S. Hussain, 2000. Dynamics of vegetable production, distribution and consumption in Asia. Asian Vegetable Research and Development Center (AVRDC), Tainan, Taiwan. Publication, 00-498, 31-67.
11. Darmawan, D.A. and E. Pasandaran, 2000. Dynamics of vegetable production, distribution and consumption in Asia. Asian Vegetable Research and Development Center (AVRDC), Tainan, Taiwan. Publication, 00-498, 139-171.

12. Ranaweera, N.F.C. and G.A.C. De Silva, 2000. Dynamics of vegetable production, distribution and consumption in Asia. Asian Vegetable Research and Development Center (AVRDC), Tainan, Taiwan. Publication, pp: 00-498.
13. Bohórquez, C. and S. Herrera 2005. Determinación de las mejores condiciones de hidrólisis del banano verde de rechazo, Tesis (pregrado), Facultad de Minas, Universidad Nacional de Colombia, sede Medellín, Medellín.
14. Akinbami, J.F.K., M.O. Ilori, T.O. Oyebisi, I.O. Akinwumi and O. Adeoti O. 2001. Biogas energy use in Nigeria: current status, future prospects and policy implications. Renewable and Sustainable Energy Reviews, 5: 97-112.
15. Omer, A.M. and Y. Fadalla, 2003. Biogas energy technology in Sudan. Renewable Energy, 28: 499-507.
16. Reddy, B.S., 2003. Overcoming the energy efficiency gap in India's household sector. Energy Policy, 31: 1117-1127.
17. Heiermann, M., M. Plöchl, B. Linke and H. Schelle, 2002. Preliminary evaluation of some cereals as energy crops for biogas production. In A.A.M. Sayigh, ed, Renewable Energy: Renewables World's Best Energy Option. Proceedings of the World Renewable Energy Congress VII, 29 June - 05 July 2002, Cologne (D), pp: 5.