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Study of Biogas Generation from Cashew Apple Waste

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ABSTRACT

Cashew (Anarcadium Occidentale L.) fruit belongs to the Anacardiaceae family. Cashew tree cultivation is done primarily aiming cashew nut production in India. However, the large amounts of cashew apples are considered as agricultural waste and the by-product of cashew nut production. In India total production of cashew is 779.34 thousand metric tons and production of Maharashtra alone is 256.61 thousand metric tons (32.93 % of the total production). Cashew nuts represent only 10% of the total fruit weight, and large amounts of cashew apples are left in the field after the removal of the nut. About 10-15 tons of cashew apples are obtained as a by-product for every ton of cashew nuts produced. This cashew apple is utilized for production of ethanol and different value-added products such as cashew apple juice, cashew apple syrup, cashew apple pickle, cashew apple feni, cashew apple wine, cashew apple sweet candy, cashew apple spice candy, cashew apple jelly, cashew apple jam, cashew apple chutney, cashew apple juice powder, etc. also from the cashew apple waste squash the cattle feed is produced. After processing of cashew apple, left cashew apple waste can be used as a biogas substrate. In this study the biogas generation from cashew apple waste is studied. The Vengurla-4 variety of cashew apple was selected for the study. Cow dung was used as inoculum, and the retention period was 30 days. The four combinations were selected with cashew apple waste and
cow dung as 100:1, 75:25, 50:50 and 25:75. The slurry was filled in 5 lit bottles with 3 lit digester and 2 lit gas holder and bottles kept for 30 days. The moisture content, volatile matter, ash content and fixed carbon was found to be 40.06%, 49.31%, 2.23% and 8.4% respectively. The C/N ratio should be 20:1 to 30:1 for proper biomass digestion, and it was found 30.5:1 and it was satisfactory for the biogas production. The combination with 25:75 showed 1ml of biogas production from 30 days of retention period which was found to be highest production between four combinations. This study showed that the biogas can be generated from the cashew apple waste. Biogas can be produced from cashew apple waste but the production was very less when there only cashew apple waste was used, but if cow dung was used as inoculum then biogas production increases as it enhances the biogas generation.

Key words: Cashew apple waste, biogas, cow dung, retention period.

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1. INTRODUCTION

The cashew (Anacardium Occidentale L.) fruit belongs to Anacardiaceae family. India being the leader in the world in raw cashew nut production and also the largest supplier of cashew kernels to the major world markets. The current cashew nut production in India accounts for 45% of the global production. It is observed that in India cashew plantation area was 1040.89 thousand ha of which Maharashtra had more area with 186.20 thousand ha (17.89 % of the total area) followed by Andhra Pradesh. With respect to production, in India total production is 779.34 thousand metric tons and production of Maharashtra alone is 256.61 thousand metric tons (32.93 % of the total production). With respect to productivity, average yield of cashew in India was found to be 762 kg per hectare. Maharashtra stands in first position with productivity of 1378 kg per hectare which is almost double the national average yield.

Cashew apple is a thick receptacle or pseudo fruit of the cashew tree (Anacardium Occidentale L.), to which the cashew nut is attached. About 10-15 tons of cashew apples are obtained as a by-product for every ton of cashew nuts produced. These are elongated, round or pear-shaped fibrous fruits and are found in three colors, viz. yellow, orange and bright red weighing between 40 to 80 g and 60-100 mm in length. About 65 to 85% of the juice can be recovered from the fruits depending upon maturity, variety and process of extraction.

There are different products produced from the Cashew apple products which are as follows Cashew apple juice, Cashew apple syrup, Cashew apple pickle, Cashew apple feni, Cashew apple wine, Cashew apple sweet candy, Cashew apple spice candy, Cashew apple jelly, Cashew apple jam, Cashew apple chutney, Cashew apple juice powder, Ethanol, etc. also from the cashew apple waste squash the cattle feed is produced. So as the cashew apple waste squash is available on the large scale, it is needed to use that for the biogas production as it will help to produce the income in rural areas.

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials like agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Its calorific value is 20 MJ/m^3. The gas is useful as a fuel substitute for the firewood, dung, agricultural residues, petrol, diesel, and electricity, depending on the nature of the task, and local supply conditions. Biogas is a cheap and clean gas which burns with a soot free blue flame. The waste is produced after the processing of cashew apple and it is utilized as manure for agricultural fields. this waste is highly perishable and its availability is large. as cashew apple is considered an agricultural residue rich in reducing sugars (fructose and glucose), vitamins, minerals and some amino acids, can be a suitable low cost substrate for anaerobic digestion. as the waste is converted into biogas, it can be used as a fuel for cooking, lighting or any other means. this will generate the income opportunities for farmers from the cashew apple waste.

2. MATERIAL AND METHODS

2.1 Extraction of cashew apple juice

The cashew apple juice was extracted from cashew apple juice extractor machine available in the FMP Workshop, CAET, Dapoli. The Vengurla-4 variety was selected available in SWCE Watershed Park, CAET, Dapoli. The juice collected from the outlet of the machine was nearly 83% of total volume of raw cashew apple The total 18kg of cashew apple was used for juice extraction from which 14.80 lit juice and 3.186 kg cashew apple squash was collected. Then this cashew apple squash was used as substrate for biogas production.

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Fig 1. Cashew apple juice extractor

2.2 Characterization of cashew apple waste:

The cashew apple waste utilized for biogas generation was tested in laboratory for various chemical parameters in order to determine whether its chemically fit for anaerobic digestion or not. The various tests are as follows-

2.1.1. Moisture Content

The moisture content of biomass was determined by ASTM D-3173 procedure.

$$\text{M.C. (\%)} = \frac{W2 - W3}{W_2 - W_1} \times 100$$

2.2.2. Volatile Matter Content

The volatile matter of biomass was determined by ASTM D-3175 procedure.

$$\text{V.M. (\%)} = \frac{W4 - W3}{W_2 - W_1} \times 100$$

2.2.3. Ash Content

The ash content of biomass was determined by ASTM D-3174 procedure.

$$\text{A.C. (\%)} = \frac{W5 - W1}{W_2 - W_1} \times 100$$

2.2.4. Fixed Carbon Content

The percentage of fixed carbon was estimated by deducting the moisture content, volatile matter and ash content from hundred. It is given by,

F.C. (%) = 100 – (M.C. + V.M. + A.C.)

2.2.5. C:N Ratio

It is one of important chemical parameters for methane production. The value of C:N ratio must lie in range of 20:1 to 30:1. The various empirical formulae for determining C:N Ratio are as follows

% Carbon = 0.9F.C. + 0.7(V.M. – 0.1A.C.) – M.C.(0.6 –

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0.01M.C.)

% Nitrogen = 2.1 – 0.02V.M.

$$\text{C:N Ratio} = \frac{\%\ \text{Carbon}}{\%\ \text{Nitrogen}}$$

2.3 Procedure for biogas generation:

For generation of biogas, water was added in to the cashew apple waste in the ratio of 1:6 to fulfill the requirement of solid content as 8-10%. The cow dung was required initially as inoculum for starting of anaerobic digestion.

Four replications of cashew apple waste with cow dung were decided for analyzing potential of cashew apple waste to produce biogas. They were follows-

Table 1: Combinations for four replications

Combination	Cashew Apple Waste (%)	Cow Dung (%)
A	100	-
B	75	25
C	50	50
D	25	75

Table 2: slurry combinations for biogas generation

Sr. No.	combination %	Weight of Cashew apple waste		Weight of cow dung		Volume of water	
		gm	ml	gm	ml	(1:6) ratio with cashew apple waste, ml	(1:2) ratio with cow dung, ml
1	A	257.14	425.57	-	-	2571.43	-
2	B	192.86	321.43	125	250	1928.57	500
3	C	128.57	214.28	250	500	1285.72	1000
4	D	64.284	107.14	375	750	642.86	1500

The four 5 lit plastic bottles selected for the biogas generation. In these bottles 3 lit volumes was acting as a digester by filling slurry up to 3 lit and remaining portion of 2 lit was acting as a gas holder for biogas storage. The hole was made on the cap of bottle for the fitting of rubber pipe. These bottles were filled with slurry and kept for 30 days as retention period.

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A B C D

Fig. 2: Combinations before experiment

A B C D

Fig. 3: Combinations after experiment

The slurry combinations of cashew apple waste, water and cow dung were as follows-

2.3. Measurement of biogas:

The biogas generated after the retention period of 30 days was measured by the water displacement method. The materials required are-

i. Measuring cylinder – 10 ml

ii. Water

iii. Rubber tube

The measuring cylinder of 10 ml was filled with 5 ml water. Then the rubber was connected to the outlet of bottle and the other end of tube was inserted into the measuring cylinder. After inserting the rubber tube, level of water in the measuring cylinder was recorded. After passing biogas into the water in the measuring cylinder through the rubber tube, the level of water rises. Then also the level of water after passing biogas was recorded. The volume of biogas can be calculated by the difference between the initial and final volume levels of measuring cylinder containing water.

The biogas was measured by water displacement method and it was found to be 0.5 ml in C combination and 1 ml in D combination. In combination A and B there was very small displacement occur.

3. RESULTS AND DISCUSSION

4. After characterization of cashew apple waste the moisture present was found to be 40.06%, volatile matter 49.31%, ash content 2.23% and fixed carbon 8.4%. The C/N ratio was found to be 30.5:1

Table 3: Composition of cashew apple waste

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Sr. No.	Parameters	Amount
1.	Moisture Content	40.06%
2.	Volatile Matter	49.31%
3.	Ash Content	2.23%
4.	Fixed Carbon	8.4%
5.	% Carbon	33.933 %
6.	% Nitrogen	1.114%
7.	C:N Ratio	30.5:1

5. CONCLUSION

- Biogas can be produced from cashew apple waste but the production was very less when there only cashew apple waste was used. But if cow dung was used as inoculum then biogas production increases as it enhances the biogas generation.
- The C/N ratio was found to be 30.5:1 and it was satisfactory for the biogas production.
- Thus, cashew apple waste can be used as a biogas substrate.

6. REFERENCES

Chopade, V. J., Khandetod, Y. P., Mohod A. G. and Birwatkar, V. R. 2016. "Ethanol production from cashew apple through solar still distillation." *National Seminar on Strategies for Development of Cashew*, 19-20 Feb, pp. 80.

Mahantesh, N. and Manjunatha, P. 2018. "Trends in Area, Production, Yield and Export Import of Cashew in India- An Economic Analysis." *Int. J. Curr. Microbiol. App. Sci*, vol. 7(12), pp. 1088-1098.

Mini, C. 2007. "Utilization of cashew apple and its by-products." *National Seminar on Research, Development and Marketing of Cashew.* Souvenir and extended summaries, ICAR Research Complex for Goa, pp. 92-98, 20-21st November.

Runjala, S., and Kella, L. 2017. "Cashew apple (Anacardium Occidentale L) therapeutic benefits, processing and product development: An overview." *The Pharma Innovation Journal,* vol. 6(7), pp. 260-264.

Shimpi, A. J., Relekar, P. P. and Pujari, K. H. 2016. "Studies on preservation of cashew apple (Anacardium occidentale L.) juice." *National Seminar on Strategies for development of cashew,* pp. 79, 19-20 Feb

Vidhya, P., Anasuya, G., and Mutnuri, S. 2013. "Biochemical Methane Potential of Agro Wastes." *Journal of Energy,* ID 350731, pp. 7.

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