www.ThePharmaJournal.com
The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2021; 10(3): 256-258

www.thepharmajournal.com
Received: 25-01-2021
Accepted: 27-02-2021

Shradha Shetty
Department of Livestock Production Management, College of Veterinary Sciences, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

John Abraham
Instructional Livestock Farm Complex, College of Veterinary Sciences, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Balusami C
Department of Livestock Production Management, College of Veterinary Sciences, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Sabin George
Department of Livestock Production Management, College of Veterinary Sciences, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Renuka Nayar
Livestock Products Technology, College of Veterinary Sciences, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Corresponding Author:
Shradha Shetty
Department of Livestock Production Management, College of Veterinary Sciences, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, Kerala, India

Biogas production and composition from single stage and two stage digesters in hilly areas

Shradha Shetty, John Abraham, Balusami C, Sabin George and Renuka Nayar

Abstract
A study was carried out to evaluate the effects of climate on the production and composition of biogas in two different types of digesters *viz.,* single stage (D_1) and two stage (D_2) digesters for a period of one year. The data collected was analysed using two-way ANOVA and the results revealed that the ambient temperature had greater influence on biogas production. The biogas production was highest in two stage digester than single stage digester in all seasons. The biogas production was significantly highest during summer season (1.74 ± 0.05 in D_1 and 1.98 ± 0.06 m^3/d in D_2) while least during winter season (0.73 ± 0.03 in D_1 and 0.97 ± 0.03 m^3/d in D_2). The concentration of methane was also highest during summer (52% in D_1 and 58% in D_2) followed by monsoon (51% in D_1 and 56% in D_2) and least during winter season (48% in D_1 and 53% in D_2). Thus, climate had greater influence on both production and composition of biogas and in order to maintain optimum production throughout the year, it is necessary to provide digester heating.

Keywords: biogas production, biogas composition, single stage, two stage, season

Introduction
With the growing population, the demand for energy is increasing. To meet the requirements, the countries are shifting towards renewable sources of energy. Biogas being one such renewable source, which is also influenced by climatic conditions. India being a tropical country enjoys the benefit of bright sunlight but, in hilly areas like Wayanad, the temperature varies greatly throughout the year affecting the biogas production. Thus, a study was conducted to evaluate the effect of climate on the production and composition of biogas in two different types of digesters.

Materials and Methods
The study was carried out at the Biogas Research Laboratory, School of Bio-energy and Farm Waste Management, Kerala Veterinary and Animal Sciences University, Pookode, Wayanad, which is located at an altitude of 867 meters from the MSL. The area is highly humid with heavy rainfall from South West and North East monsoon from June to September and October to November, respectively causing greater variations in the temperature throughout the year. The research was carried out for a period of one year from June 2019 to May 2020 covering all the seasons. The seasons were classified as shown in Table 1. The important macro-climatic variables like ambient temperature and relative humidity were recorded daily using an automatic weather station

Table 1: Climatic classification of Pookode

Monsoon season	Winter season	Summer season
June	October	February
July	November	March
August	December	April
September	January	May

(Source: [1])

The study involved two different digesters, *viz.,* single stage digester (D_1) and two-stage digester (D_2) of 3000 l capacity each. The D_1 had a single compartment where all the four stages (hydrolysis, acidogenesis, acetogenesis and methanogenesis) of anaerobic digestion occurred, while in D_2 the whole digester was divided into two equal compartments with a median septum. Within each compartment there were vertical baffles which restricted the movement of the digestate through it, thereby providing increased surface area for the microbes to be in close contact with the organic matter. The first compartment was acidogenic chamber while the second was methanogenic chamber. In methanogenic chamber an alkaline pH of 8.5 was maintained by adding sodium bicarbonate as methanogens operated in a strict pH of 6.8-8.5 [2]. Both the digesters were daily fed with 25 kg of kitchen waste and 25 kg of cow dung diluted with 50 l of water. The quantity of the biogas produced was recorded using biogas flow meter (CLESSE CGS-4) and the composition of biogas was analysed using biogas analyser (Model No. L-314 Precision Scientific).

The data obtained were statistically analysed using analysis of variance (two-way ANOVA) as described by [3] using SPSS version 24.0® software.

Results and Discussion

During winter season the atmospheric temperature was lowest ranging from 21.2 ºC to 22.7 ºC and during summer season, it was highest varying from 24.9 ºC to 27.2 ºC. During monsoon season, ambient temperature was between 21.6 ºC to 22.6 ºC. The lowest RH values were ranging from 60.3 to 66.5 per cent during summer season. The highest RH values were ranging from 89 to 93.5 per cent during monsoon season and during winter season the RH values was in the range of 85.3 to 87.2 per cent. The mean values of temperature and RH are presented in Table 2.

Table 2: Mean temperature and relative humidity during different seasons

Seasons	Temperature (° C) (Mean ± SE)	Relative Humidity (%) (Mean ± SE)
Winter season (December to February)	21.63 ± 0.258	89.33 ± 0.71
Summer season (March to May)	26.06 ± 0.359	63.33 ± 1.28
Monsoon season (June to August)	22.18 ± 0.164	92.50 ± 1.33

The biogas production was highest in D_2 than D_1 during all the seasons. The results of the biogas production during different seasons are presented in Table 3.and the data reveals that, the biogas production was significantly (P <0.01) higher in summer season (1.74 ± 0.05 and 1.98 ± 0.06 m^3/d in D_1 and D_2) followed by monsoon season and least during winter season (0.73 ± 0.03 and 0.97 ± 0.03 m^3/d in D_1 and D_2). The biogas production reduced during winter season mainly due to lowered ambient temperature and also stated that the biogas production increased exponentially with increase in temperature [4, 5]. The lower ambient temperature lowered the microbial activity and substrate utilisation thereby, affecting the biogas production [6].

Table 3: Biogas production during different seasons in D_1 and D_2

Seasons	D_1 (m^3/d)	D_2 (m^3/d)
Monsoon season	1.08 ± 0.13^b	1.26 ± 0.05^b
Winter season	0.73 ± 0.03^c	0.97 ± 0.03^c
Summer season	1.74 ± 0.05^a	1.98 ± 0.06^a

Means with different superscript differ significantly

There was a significant difference (P<0.01) in the composition of the biogas, between the digesters. The biogas obtained from D_2 had higher methane content than that obtained from D_1. The increased methane content in D_2 was mainly due to phase separation which enhanced the methanogenic microbial activity and rate of degradation of organic matter thereby providing readily available volatile fatty acids (VFAs) to methanogens.

In both the digesters, the concentration of methane increased during summer season while during winter seasons when the ambient temperature was low, the concentration of methane decreased while that of carbon-dioxide increased (Fig. 1 and 2). Depending on the digester temperature, the composition of biogas varied [7]. The higher the digester temperature greater was the methane concentration.

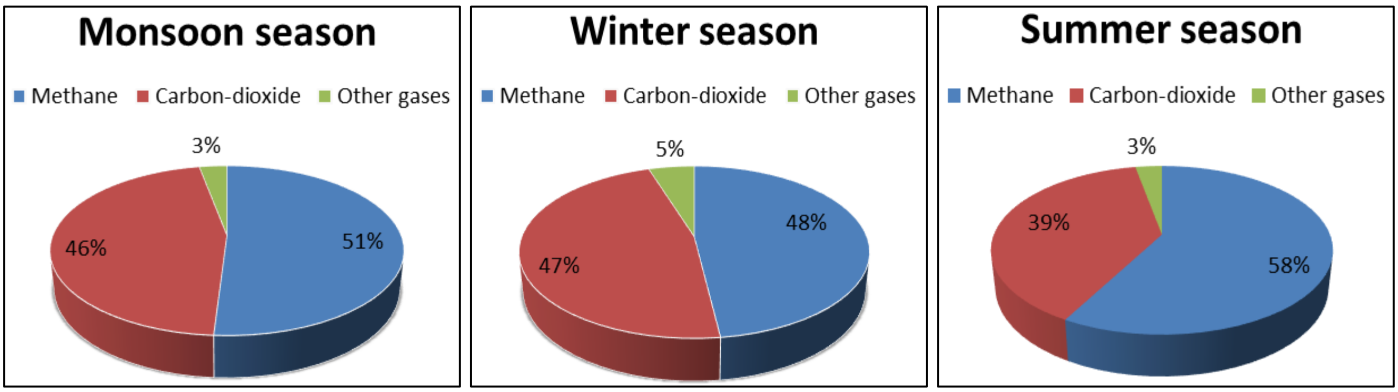

Fig 1: Composition of biogas during different seasons in single stage digester

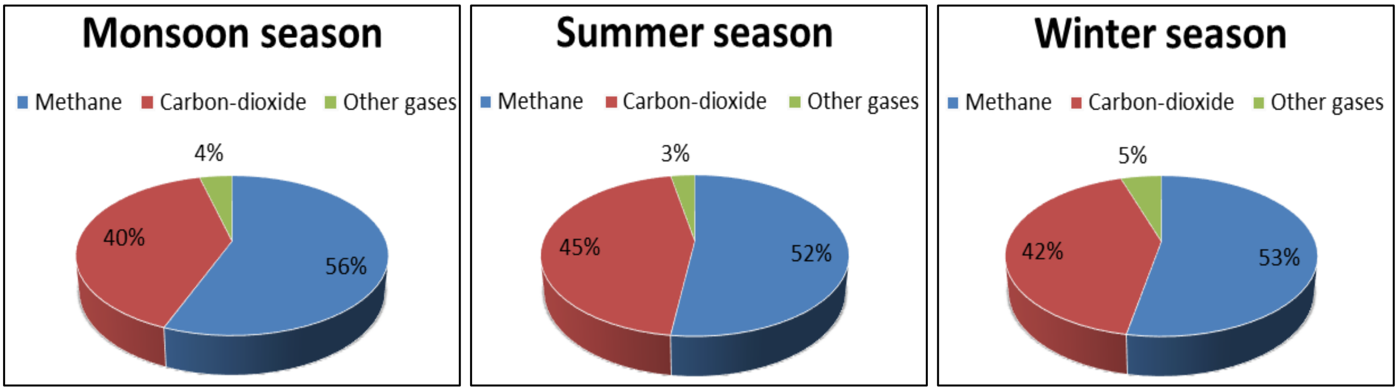

Fig 2: Composition of biogas during different seasons in two stage digester

Conclusion

The study concluded that the ambient temperature and seasons had greater effect on the biogas production and composition in both the digesters. During all seasons, the quantity of biogas and concentration of methane was significantly higher in D_2 than D_1. Within seasons, the quality and quantity of biogas obtained was superior during summer season followed by monsoon season. During winter season, as the ambient temperature was low, digester temperature decreased affecting the production and composition of biogas. Thus, in hilly areas where the ambient temperature is very low during colder months, it is essential to provide digester heating in order to obtain optimum biogas production throughout the year.

Acknowledgement

We give our appreciations to the financial supports from the Indian Council of Agricultural Research and Kerala Veterinary and Animal Sciences University, Pookode, Kerala, India.

References

1. Danesh K, Pavan S. Climate Trends in Wayanad: Voices from the Community. UGC sponsored National Seminar. In: 'Recent Trends in Climate & Impact of Climate Change on South-West India'. 11th October, St. Joseph's College, Kozhikode, Kerala 2011
2. Nijaguna BT. Biogas Technology. New Age International Publishers, New Delhi 2016, 56p.
3. Snedecor GW, Cochran WG. Statistical Methods. 8th Ed. The Iowa State University Press, Iowa, USA 1994, 564p.
4. Hamad MA, Dayem AA, El Halwagi MM. Evaluation of the performance of two rural biogas units of Indian and Chinese design. Energy Agriculture 1981;1:235-250.
5. Sorathia HS, Rathod PP, Sorathiya AS. Bio-gas generation and factors affecting the bio-gas generation: A review study. International Journal of Advanced Engineering. Technology 2012;3(2):72-78.
6. Abdelgadir A, Chen X, Liu J, Xie X, Zhang J, Zhang K *et al.* Characteristics, process parameters, and inner components of anaerobic bioreactors. Bio Med Research International 2014, 1-10.
7. Chae, KJ, Jang AM, Yim SK, Kim IS. The effects of digestion temperature and temperature shock on the biogas yields from the mesophilic anaerobic digestion of swine manure. Bioresource. Technology 2008;99(1):1-6.