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CG Varma
Veterinary Assistant Surgeon, Veterinary Dispensary, DIMILI, Rambilli Mandal, Visakhapatnam, Andhra Pradesh, India

Deepak Mathew DK
Assistant Professor, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

Manju Saseedharan
Assistant Professor, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

Kannan A
Associate Professor, Department of Livestock Production Management, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala, India

Corresponding Author:
CG Varma
Veterinary Assistant Surgeon, Veterinary Dispensary, DIMILI, Rambilli Mandal, Visakhapatnam, Andhra Pradesh, India

Analysis of manurial value of the slurry obtained through anaerobic digestion of livestock manures

CG Varma, Deepak Mathew DK, Manju Saseedharan and Kannan A

Abstract
Biogas slurry is a good source of plant nutrients and can improve soil fertility and properties. These nutrients are mainly nitrogen, phosphorus and potassium (macro) and magnesium, calcium and manganese (micro) elements. The value of bio-slurry as a fertilizer depends on the nutrient contents. Two Kg. fresh manure of the farm animals namely cattle, goat, poultry and swine in 1:1 ratio *viz.*, T1 (cattle manure), T2 (goat manure), T3 (poultry), T4 (swine manure) were used as substrate to study the manurial value of slurry obtained after anaerobic digestion. The moisture content of on fresh basis was 91.31 ± 0.09, 92.33 ± 0.04 and 90.68 ± 0.09 percent respectively. The goat slurry was having the highest dry matter content.

Keywords: Plant nutrients, soil fertility, properties, livestock manures

Introduction
Intensification of agriculture has led to increased use of synthetic fertiliser which is high in cost and decreases fertility of soil from time to time. As a result, the soil health has started to deteriorate. To overcome this problem Organic manures such as cow dung, poultry manure, crop residues and biogas slurry in liquid and composted form can be used as organic fertilizer [1]. Bioslury obtained from the biogas plant may be considered as a good source of organic fertilizer as it contains considerable amounts of both macro and micronutrients, so using organic fertilizer (bioslury) can have economic value chain in crop production. Bioslury is an anaerobic digested organic material released as a digestant from the biogas plant after production of combustible biogas for cooking and lighting. Biogas slurry is a good source of plant nutrients and can improve soil fertility and properties. These nutrients are mainly nitrogen, phosphorus and potassium (macro) and magnesium, calcium and manganese (micro) elements. The value of bio-slurry as a fertilizer depends on the nutrient contents, e.g., the amount of nitrogen, phosphorus, potassium, calcium and magnesium [2], the ratio between nutrients in the bio-slurry, e.g., the N/P-ratio and/or the N/K-ratio [3]; and the availability of the nutrients, which is determined by the compounds that contain the nutrients. In this context, the present study aimed at to assess the fertilizer value of sludge obtained.

Materials and Methods
The study was conducted to evaluate co-digestion of livestock manures utilizing portable floating drum biogas plants of 0.5 m^3 capacity, designed by Agro Biotechnology Agency for Rural Employment Development (ABARD), Kerala Agricultural University (KAU), Vellanikara. Two Kg. fresh manure of the farm animals namely cattle, goat, poultry and swine in 1:1 ratio *viz.*, T1 (cattle manure), T2 (goat manure), T3 (poultry), T4 (swine manure) were used as substrate. Water is added in each treatment at 1:1 ratio on whole weight basis (Nijaguna 2012) [11]. Before loading, fresh samples of the substrates from each treatment were collected and analyzed to determine TS and N content.
Moisture and Dry Matter of slurry were determined (Chandra *et al.*, 2012) once in a week, throughout the experiment period. The temperature of the slurry from each treatment was recorded once in a week in the morning (8 am) using mercury bulb thermometer (Khoiyangbam *et al*., 2004) [10]. The pH of the slurry from each treatment was recorded once in a week in the morning (8 am) using Eutech digital PCStestr 35 (Radhakrishnan, 2013) [9].
Manurial value of the slurry was determined at every week for Nitrogen (AOAC, 2012), Phosphorus (P) and Potassium (K) contents (Davis, 2017) [7].

All the samples collected were processed and representative samples were digested using Perkin Elmer Titan MPS model microwave sample preparation system. P and K content were estimated using Inductively Coupled Plasma Optical Emission Spectrometer (ICPOES) Perkin Elmer Model Optima 8000. All the values were estimated on fresh basis.

The data obtained on various parameters during the course of study were statistically analysed using analysis of variance (ANOVA) as described by Snedecor and Cochran (1994) [8]. The correlation of various meteorological parameters with biogas production was analyzed by Pearson's correlation co-efficient method. All the statistical analysis was carried out with SPSS V 24.0.

Results and Discussion

The quantity and temperature of sludge obtained from the digesters using different substrates. The amount of sludge was highest from digester using goat excreta. There was an increase in quantity and temperature of sludge during summer season.

Table 1: Quantity & Temperature of slurry obtained

Sludge	Slurry quantity (kg/day)	Slurry temperature (°C)
T1	2.6-3.1	27.6- 30.65
T2	3.7-4.2	26.85-30.68
T3	2.3-2.8	26.65 -31.15
T4	2.1-2.2	27.2-31.22

The moisture content of on fresh basis were 91.31 ± 0.09, 92.33 ± 0.04 and 90.68 ± 0.09 percent respectively. The goat sludge was having the highest dry matter content. The crude fibre content of cattle sludge on dry matter basis was higher 17.64 ± 0.05 (%), than other treatments. The pH of the sludge was higher in goat sludge (7.24 ± 0.06) than Swine sludge (7.13 ± 0.07), poultry sludge (7.03 ± 0.07) and cattle sludge (7.10 ± 0.07). The N P K content was higher in goat sludge compared to other treatments.

There existed a significant increase ($P< 0.01$) in N and P content of sludge from digesters but there was no difference in K content ($P>0.05$) of the substrate and sludge.

Table 2: Physico-chemical parameters of slurry

Sl. No.	Parameter	Cattle excreta	Goat excreta	Poultry excreta	Swine excreta
1	Moisture (%) #	91.31 ± 0.09	92.33 ± 0.04	90.68 ± 0.09	90.68 ± 0.09
2	Dry matter (%) #	8.61 ± 0.09	7.67 ± 0.04	9.32 ± 0.09	9.02 ± 0.09
3	Crude fiber (%) ##	17.64 ± 0.05	17.56 ± 0.04	14.42 ± 0.06	14.25 ± 0.06
4	pH#	7.10 ± 0.07	7.13 ± 0.07	7.24 ± 0.06	7.14 ± 0.06
5	Nitrogen (%) ##	1.87 ± 0.02	2.52 ± 0.03	3.44 ± 0.03	3.26 ± 0.03
6	Phosphorous (%) ##	1.14 ± 0.03	1.06 ± 0.02	1.43 ± 0.03	1.35 ± 0.03
7	Potassium (%) ##	0.82 ± 0.03	0.73 ± 0.01	1.12 ± 0.04	1.26 ± 0.04

The amount of sludge was highest in the digester using goat excreta. There was an increase in quantity and temperature of sludge during summer season. The increase in quantity of the sludge might be related to higher DM content of goat excreta which in turn required the addition of more water to obtain input dilution of 10 percent. The addition of more water resulted in increased quantity of sludge. The higher sludge temperature of goat excreta could be related to higher digesta temperature when compared to excreta of other species. The results showed that goat sludge showed highest DM content during the entire observation period. The CF content of cattle sludge on DM basis was higher than others, whereas the pH was higher in goat sludge. The biogas slurry consisted of 93 percent water and 7 percent DM, of which 4.5 percent was organic and 2.5 percent inorganic matter (FAO, 2007) [4]. A significant increase was observed in N and P content of sludge from digesters but there was no significant difference in K content of the substrate and sludge.

Similar findings have been reported by Deshmukh (2012) [5] who found that the sludge and remaining effluent possess good manurial value (N, P, K) and was used as a supplement to fertilizers in agriculture. Weiland (2010) [6] reviewed that the anaerobic digestion resulted in mineralization of organically bounded nutrients which in turn increased the short-term N fertilization effect. The amount of sludge was highest from digester using goat excreta. There was an increase in quantity and temperature of sludge during summer season. The changes of the manurial value of substrate and slurry is depicted in fig.1.

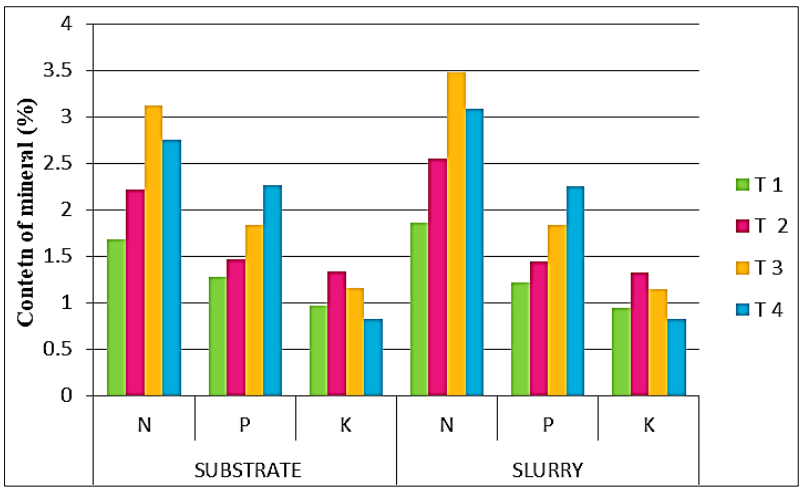

Fig 1: Manurial value of substrate and slurry

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