The Haryana Veterinarian (March, 2024) **63(SI),** 95-98 ISSN 0033-4359 (P) **Research Article**

EFFECT OF ORGANIC LOADING RATE (OLR) ON GERMINATION POTENTIAL OF BIOGAS SPENT SLURRY PRODUCED FROM ANAEROBIC DIGESTION OF PIG MANURE

NARENDER KUMAR*, CHANDRAHAS[1], MUKESH SINGH, RAJ NARAYAN[1], SUSHIL KUMAR[2], RAJNEESH and K.R. HARINI
Livestock Production and Management Section, ICAR-Indian Veterinary Research Institute,
[1]ICAR-Central Avian Research Institute, Izatnagar, Bareilly-243122, Uttar Pradesh, India
[2]Department of Animal Nutrition, Lala Lajpat Rai University of Veterinary and Animal Sciences (LUVAS), Hisar-125001, Haryana

Received: 14.09.2023, Accepted: 08.11.2023

ABSTRACT

The present study was conducted to observe the effect of OLR on germination potential of biogas spent slurry produced from anaerobic digestion of pig manure. The organic loading (Kg) was 7.5, 10, 15 and 30 and daily feeding of digester with organic substrate (kg) with 0.37, 0.50, 0.75 and 1.50 for L1, L2, L3 and L4, respectively. Pig dung was rich source of crude protein, moisture, total nitrogen, total carbon, ether extract, calcium, phosphorus and potassium. The TS (%) was significantly ($P<0.05$) higher in L4 compared to other treatment groups. Moisture (%) was significantly ($P<0.05$) lower in L4 that other treatment groups. The volatile solid content was significantly ($P<0.05$) higher in L3 followed by L2, L3 and L1. Nitrogen content was numerically higher in L2 followed by L4, L3 and L1 groups. The phosphorus and potassium content were numerically higher in L4 groups compared to other groups. The relative seed germination in crude slurry and slurry extract was not significantly differ among all groups. The germination index in crude slurry was significantly ($P<0.05$) higher in L2 compared to L3 and L4 groups whereas germination index in slurry extract did not differ significantly among all groups.

Keywords: Biogas spent slurry, Germination index, Organic loading rate (OLR), Pig manure, Slurry extract

How to cite: Kumar, N., Chandrahas, Singh, M., Narayan, R., Kumar, S., Rajneesh and Harini, K.R. (2024). Effect of organic loading rate (OLR) on germination potential of biogas spent slurry produced from anaerobic digestion of pig manure. *The Haryana Veterinarian* **63(SI)**: 95- 98.

The germination potential of anaerobic digested slurry depends upon the macro and micro nutrient present which are responsible for the growth of the plant. In India, biogas production is an age-old technology, where cow dung used to obtain slurry, however, piggery excreta have not considered for this purpose so far. The pig contributes 1.69% (BAHS, 2022) in the total Indian livestock population (9.06 million) but the piggery waste neither utilized as manure in agriculture field nor used to produce biogas as compared to other livestock waste. Non utilization of pig manure under Indian conditions may be due to some social issues. The pig dung simply washed out in the drain in our country, which is totally wastage of organic matter having good amount of nitrogen and phosphorus. In the opinion of many workers, biogas production from piggery excreta is comparatively difficult. Raw swine manure approximately contains TS (13.6%), VS (72.6 %), pH (6.5-7.13), SCOD (soluble chemical oxygen demand) 18900 mg/l, Soluble proteins (4200 mg/l), TAN (total ammonium nitrogen) 2400 mg/l, methane 50-65 %, C: N ratio 7-17:1 (Lin *et al.*, 2015). Bonmati and Flotats, (2002) also characterised both fresh and digested filtered pig slurry in his experiment and respective values of pH (7.7, 8.5), TS (g/kg) (49.06, 15.71), VS (g/kg) (30.94, 8.61), ammoniacal nitrogen (g/kg) (3.51, 1.96), total nitrogen (g/kg) (5.80, 2.59) and volatile fatty acid (g/kg) (14.85, 0.62) reported by vacuum evaporation experiment. The germination index of swine manure after composting of swine dung for a specific period of time indicates that pig dung has no toxic effect in plants after process of composting (Zucconi *et al.*,1981). The number of seed germinate did not have any adverse effect by the application of pig manure after composting of thirty weeks of swine dung (Tiquia *et al.*, 1996). The aim of the study was to observe the effect of OLR on germination potential of biogas spent slurry.

MATERIALS AND METHODS

Location of study conducted:

The study was conducted at Swine Production Farm (SPF), Livestock Production and Management Section, ICAR-Indian Veterinary Research Institute (IVRI), Izatnagar, Bareilly. The Farm was at latitude of 28° 22' North having longitude of 79° 24' east and 169.2 meter above mean sea level (MSL). The region where study conducted placed in upper gangetic plain of India.

Design of study:

Four treatment groups having organic loading rate (OLR) were L1 (1:8), L2 (1:6), L3 (1:4) and L4 (1:2) were used (Table 1). The C/N ratio of the substrate (pig dung and

*Corresponding author: nklangyan@gmail.com

wheat straw) was maintained at ratio of 25:1. After the 3 months of the experiments the biogas spent slurry of different OLR subjected to seed germination. For this experiment gram seeds (N=20) were used and germinated in 50 ml of crude slurry and slurry extract in petri plate. The slurry extract was obtained after filtration of bio slurry through filter paper (Whatman No. 1). Parameters related to germination potential were observed after 72 hours. Relative seed germination, root length and germination index were calculated as per Tiquia *et al.*, 1996 and Zucconi *et al.*, 1981.

Proximate analysis:

Proximate of pig dung as well as spent slurry was done to calculate the percentage of dry matter (DM), moisture percent, crude protein (CP), crude fibre (CF), ether extract (EE) and total ash was estimated for every group at an interval of 0, 45 and 90 days of trial. The above parameters were calculated through standard procedure of AOAC (2007).

Manurial value of swine slurry:

Manurial values of slurry were estimate through the availability of nitrogen, phosphorus, potassium and sulphur content present in the swine slurry. These minerals were estimated by their standard procedure.

Statistical analysis:

The generated data from the experiment subjected to statistical analysis using Software Package for Social Sciences (IMB, SPSS, version 26). One way ANOVA was used to calculate the difference among the different treatment groups (Snedecor and Cochran, 1989). Tukey test was used to compare the significant difference among treatment group.

RESULTS AND DISCUSSIONS

Composition of pig dung:

The finding showed that pig dung was rich source of crude protein, moisture, total nitrogen, total carbon ether extract. Pig dung also encompassed with good measurable amount of calcium, phosphorus and potassium. The pH of the pig dung was found to be acidic, having electrical conductivity of 5456.33 S/cm (Table 2).

Wang *et al.* (2014) reported that C/N ratio affects the anaerobic digestion of manure for efficient production of biogas. Electrical conductivity (EC) also plays major a role which directly indicates the concentration of salt in organic waste (Azeez and Van Averbeke, 2012). Brummeler and Koster (1989) reported that the acidogenic microorganism requires pH in the range of 5.5-6. Total solid and moisture percentage was similar as recorded by Lin *et al.* (2015) and Sarda Prasanna Sahu, 2017.

Composition of biogas spent slurry:

The proximate analysis of biogas slurry was done and recorded observations presented in Table 3. The TS (%) was significantly ($P<0.05$) higher in L4 compared to other treatment groups. Moisture (%) was significantly ($P<0.05$) lower in L4 that other treatment groups. The volatile solid content was significantly ($P<0.05$) higher in L3 followed by L2, L3 and L1 however in L2 and L4 no significant difference was observed. The carbon content was significant ($P<0.05$) higher in L3 compared to L1, L2 and L4 group. Ash (%) was found significantly ($P<0.05$) higher in L4 compared to other treatment groups. Ether extract percent was numerically higher in L2 than other groups but only significantly differed with L1 group. There was no significant difference observed in other parameters like CP(%), CF (%), N (%) and C:N ratio among all treatment groups.

Xiang *et al.* (2021) estimated the pig slurry produced from co-digestion of rice straw and pig manure and found pH, total solid, volatile solid, C and N were 8.76, 18.27%, 77.28%, 33.12% and 2.26%, respectively. Arhoun *et al.* (2021) conducted anaerobic digestion of pig slurry for efficient biogas production and found pH, TS (%), VS (%), N (%), in spent slurry were 7.0, 2.58, 1.46 and 4.90, respectively. Haner *et al.* (2022) also studied the anaerobic digestion of pig slurry and observed pH, DM (%) and ODM (%) total nitrogen of the pig slurry were 7.93, 1.9, 61.1 and 0.28%, respectively.

Manurial value of pig dung slurry:

The manurial value of pig dung slurry was estimated among all treatment groups, but no significant difference was observed among all treatment groups. Nitrogen content was numerically higher in L2 followed by L4, L3 and L1 groups. The phosphorus and potassium content were numerically higher in L4 groups compared to other groups. The lowest concentration of phosphorus and potassium were found in L2 and L3 groups, respectively. The sulphur content was almost similar among all group but numerically higher in L1 and lowest in L3 treatment group (Table 4).

Ahmed *et al.* (2009) studied that good amount of NPK present in the spent slurry as good fertilizer and leads to increase in crop yield. Serge *et al.* (2012) compared the bio slurry & chemical fertilizer and found that bio slurry composed of good amount of NPK act as alternative source in place of chemical fertilizer. Haner *et al.* (2022) also studied manurial value anaerobic digested pig slurry and amount of total nitrogen, ammoniacal nitrogen, potassium

Table 1. Work plan showing different treatment group for biogas production

Groups	L1	L2	L3	L4
Dilution rate	1:8	1:6	1:4	1:2
Initial loading of pig manure (Kg)	1 part (7.5)	1 part (10.0)	1 part (15.0)	1 part (30.0)
Quantity of water used (Litres)	8 parts (60)	6 parts (60)	4 parts (60)	2 parts (60)
Carbonaceous material (Wheat straw in Kg)	1.20	1.50	2.50	4.83
Inoculum (Cow dung, 2% w/v); once used in the beginning as starter culture	1.35	1.4	1.5	1.8
Daily loading of pig faeces (Kg)	0.37	0.50	0.75	1.50

oxide, magnesium oxide, calcium oxide and sulphur were 0.28%, 0.22%, 0.06%, 0.22%, <0.05%, <0.1 and 0.04, respectively.

Germination potential of pig dung slurry:

The germination potential test of all treatment group was carried out using pig dung slurry crude and slurry extract at the end of the experiment (Table 5). The gram seed was poured in the crude biogas slurry and slurry extract using petri plate for a period of seventy-two (72) hours. The relative seed germination in crude slurry and slurry extract was not significantly differ among all groups; however, it was numerically higher in L1 followed by L2, L3 and L4 groups. The relative root growth in crude slurry and slurry extract was also did not differ significantly among all the groups but relative root growth in crude slurry was numerically higher in L1 and lowest in L4 group, similarly relative root growth in slurry extract was highest in L1 and lowest in L2 group. The germination index in crude slurry was significantly ($P<0.05$) higher in L2 compared to L3 and L4 groups whereas germination index in slurry extract did not differ significantly among all groups but numerically highest in L1 and lowest in L4 group.

The relative seed germination in crude slurry and slurry extract was not significant among all treatment group but values are numerically lower in L4 group and

Table 2. Proximate analysis of pig dung

Parameters	Pig Dung
Total solid (%)	23.35 ± 0.26
Volatile solid (%)	83.76 ± 0.21
Moisture (%)	76.65 ± 0.26
Total carbon (%)	48.58 ± 0.13
Total nitrogen (%)	2.52 ± 0.014
CP (%)	15.77 ± 0.92
Ash (%)	16.23 ± 0.22
AIA (%)	3.40 ± 0.11
CF (%)	16.57 ± 0.75
EE (%)	6.57 ± 0.54
Ca (%)	2.83 ± 0.65
P (%)	1.36 ± 0.33
K (%)	1.50 ± 0.27
C/N ratio	19.25 ± 0.12
pH	6.27 ± 0.08

Table 3. Proximate analysis and C/N ratio of spent slurry in different treatment groups

Parameters	L1 (N=6)	L2 (N=6)	L3 (N=6)	L4 (N=6)
Total solid (%)	$7.65^{a} \pm 0.34$	$7.66^{a} \pm 0.47$	$8.14^{a} \pm 0.35$	$11.93^{b} \pm 0.99$
Volatile solid (%)	$79.32^{a} \pm 0.97$	$82.37^{b} \pm 0.46$	$86.62^{c} \pm 0.78$	$82.02^{b} \pm 0.44$
Moisture (%)	$92.34^{b} \pm 0.33$	$92.33^{b} \pm 0.47$	$91.85^{b} \pm 0.35$	$88.07^{a} \pm 0.10$
CP (%)	14.44 ± 0.82	15.19 ± 0.91	14.98 ± 0.79	14.63 ± 0.46
Ash (%)	$13.37^{a} \pm 0.78$	$17.62^{b} \pm 0.46$	$17.97^{b} \pm 0.44$	$20.68^{c} \pm 0.97$
CF (%)	8.84 ± 0.59	9.33 ± 0.70	8.03 ± 0.69	8.50 ± 0.51
EE (%)	$6.37^{a} \pm 0.23$	$8.40^{b} \pm 0.48$	$7.24^{ab} \pm 0.56$	$7.73^{b} \pm 0.37$
C (%)	$46.01^{a} \pm 0.56$	$47.77^{b} \pm 0.27$	$50.24^{c} \pm 0.45$	$47.57^{b} \pm 0.26$
C/N ratio	20.37 ± 1.05	19.34 ± 1.48	21.35 ± 0.97	20.47 ± 0.62

Means with different superscripts in a row differ significantly ($P<0.05$)

Table 4. Manurial value (N, P, K and S) of spent slurry in different treatment groups

Parameters (%)	L1 (N=6)	L2 (N=6)	L3 (N=6)	L4 (N=6)
N	2.24±0.41	2.92±0.35	2.41±0.43	2.46±0.36
P	0.91±0.18	0.89±0.14	0.92±0.15	1.01±0.16
K	2.34±0.26	2.15±0.24	2.08±0.30	2.38±0.36
S	0.55±0.046	0.50±0.038	0.40±0.017	0.47±0.027

Table 5. Germination potential of spent slurry variants under different treatments

Parameters	L1	L2	L3	L4
Relative seed germination in crude slurry (%)	33.31 ± 0.98	35.24 ± 2.68	31.45 ± 2.08	29.97 ± 2.53
Relative seed germination in slurry extract (%)	26.26 ± 2.77	22.84 ± 1.84	19.42 ± 2.33	17.48 ± 1.28
Relative root growth in crude slurry (%)	34.73 ± 2.49	31.69 ± 1.77	31.72 ± 2.54	31.14 ± 0.91
Relative root growth in slurry extract (%)	28.95 ± 2.17	28.36 ± 2.88	31.69 ± 1.76	31.29 ± 2.07
Germination index in crude slurry	$13.09^{ab} \pm 0.58$	$14.15^{b} \pm 1.01$	$9.23^{a} \pm 1.06$	$9.31^{a} \pm 0.71$
Germination index in slurry extract	7.48 ± 0.23	6.37 ± 0.16	6.23 ± 1.01	5.45 ± 0.41

Means with different superscripts in a row differ significantly ($P<0.05$)

higher in L1 group due to higher TDS and higher EC in L4 compared to L1. The higher concentration of salt and total dissolved solid in spent slurry had negative impact of soil microorganisms which retard the growth of the crops (Azeez and Van Averbeke, 2012). The relative root growth in crude slurry and extract showing non significance difference which due to similar concentration of nitrogen, phosphorus and potassium (NPK) among all groups. Parry *et al.* (2005) studied that optimum concentration of nutrients are required for growth and development of shoot, root and more yield of crop. The germination index in crude slurry and slurry extract was lower in L4 group compared to other groups and highest L1 group because of high loading of organic substrate and high TDS and EC also had negative impact on germination index.

CONCLUSION

The conducted study found that bio-spent slurry produced from anaerobic digestion of pig manure has better manurial value and higher germination index in crude slurry and slurry extract was better at diluted form.

REFERENCES

Ahmad, R. and Jabeen, N. (2009). Demonstration of growth improvement in sunflower (*Helianthus annuus* L.) by the use of organic fertilizers under saline conditions. *Pak. J. Bot.* **41(3)**: 1373-1384.

AOAC (2007). Official methods of analysis (18th Edn.), Association of Official Analytical Chemists. Washington, DC, USA.

Arhoun, B., Malpartida Garcia, I., Villen-Guzman, M., Abdala Diaz, R.T., Garcia-Herruzo, F., and Rodriguez-Maroto, J.M. (2021). Effect of pretreatment and co-substrate addition on biogas production from pig slurry. *Water Environ. J.* **35(3)**: 1147-1157.

Azeez, J.O. and Van Averbeke, W. (2012). Dynamics of soil pH and electrical conductivity with the application of three animal manures. *Comm. Soil Sci. Plant Anal*. **43(6)**: 865-874.

Basic Animal Husbandry and Fisheries Statistics. (2022). Department of Animal Husbandry, Dairying and Fisheries. Ministry of Agriculture, Govt of India, New Delhi.

Bonmati, A. and Flotats, X. (2002). Pig slurry treatment strategy in a high livestock concentration area: anaerobic digestion as the key process. In Latin American Workshop and Symposium on Anaerobic Digestion. **7(8)**.

Haner, J., Weide, T., Naßmacher, A., Hernández Regalado, R.E., Wetter, C. and Brugging, E. (2022). Anaerobic digestion of pig slurry in fixed-bed and expanded granular sludge bed reactors. *Energies.* **15(12)**: 4414.

Lin, Y., Wang, D., Wu, S. and Wang, C. (2015). Alkali pretreatment enhances biogas production in the anaerobic digestion of pulp and paper sludge. *J. Hazard. Mater.* **170(1)**: 366-373.

Sarada Prasanna Sahoo (2017), Studies on pig manure conditioning for efficient biogas production, Doctorate thesis, ICAR-IVRI, Izatnagar, Bareilly (UP), India.

Snedecor, G. W. and Cochran, W.G. (1989). Arc sine transformation for proportions. Statistical Methods. (8th Edn.), Iowa State University Press, Ames. pp. 289-290.

Tiquia, S.M., Tam, N.F.Y. and Hodgkiss, I.J. (1996). Effects of composting on phytotoxicity of spent pig-manure sawdust litter. *Envir. Pollut.* **93(3)**: 249-256.

Wang, X., Lu, X., Li, F. and Yang, G. (2014). Effects of temperature and carbon-nitrogen (C/N) ratio on the performance of anaerobic co-digestion of dairy manure, chicken manure and rice straw: focusing on ammonia inhibition. *PloS one.* **9(5)**: e97265.

Xiang, S., Lu, F., Liu, Y. and Ruan, R. (2021). Pretreated rice straw improves the biogas production and heavy metals passivation of pig manure containing copper and zinc. *J. Clean. Prod.* **315**: 128171.

Zucconi, F., Forte, M., Monaco, A. and Bertoldi, D.E. (1981). Biological evaluation of compost maturity. *Biocycle.* **22(4)**: 27-29.