AD 14th WORLD CONGRESS ON ANAEROIC DIGESTION

PERFORMANCE EVALUATION OF ANAEROBIC DIGESTION AND CO-DIGESTION OF SOLID ORGANIC WASTES IN SEMICONTINUOUS REACTORS

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INTRODUCTION

In recent decades the anaerobic digestion of organic waste is a valid alternative for the production of renewable energies on farm animals.

However, this process is vulnerable to inhibition by several factors, namely ammonia (NH_3) and ammonium ion (NH_4^+). High concentrations of these species, predominantly in monogastric animals (poultry and pig) manure, can seriously challenge anaerobic digestion. Mix of substrates (co-digestion), dilution of manure and acclimation of microorganism, are some mechanisms studied to avoid the ammonia inhibition.

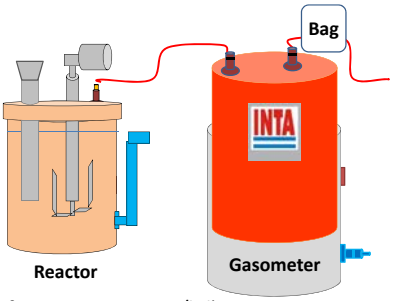
The objective of the present research was to evaluate the performance of anaerobic digestion of cattle manure, poultry manure and the co-digestion of this waste with fruit and vegetable waste.

MATERIALS AND METHODS

Experimental set up

Substrates:

- Cattle manure (CM)
- Poultry manure (PM)
- 1:1 ratio mix of PM and fruits and vegetables (PM-FVW)



✓Dilution: 8 % TS

✓Working volume: 19 l

✓Temperature: 34.5 ± 1.4 ºC

✓Period adaptation: 7 months (OLR of 0.5, 1, 1.5 y 2 gVS/l.d)

✓Steady state: OLR of 2gVS/l.d , 114 days

Parameters determined in slurry samples: pH, COD, TS, VS, VFA, AT and PA once a week; Total kjeldhal nitrogen (TKN), Total ammonia nitrogen (TAN) and free ammonia nitrogen (FAN) in the last six weeks.

In biogas: daily production (l), CH_4, CO_2 and H_2 content by gas chromatography in the last six week.

Statistic analyses: ANOVA (INFOSTAT)

RESULTS AND DISCUSSION

The anaerobic process was monitored through *alfa* (α), VFA/TA and pH indicators (Table 1). These indicators showed stable conditions for anaerobic degradation in all treatments along the experiment.

The results of VS and COD showed elevated organic material removal efficiency for both PM and PM-FVW (Table 1).

The highest TKN value was found in the PM treatment, probably due to the elevated protein content in poultry manure (Table 1). PM and PM-FVW showed higher TAN concentrations than CM.

Elevated FAN values were found in PM-FVW and PM (Figure 1). The highest FAN concentration was observed at pH >7.6 in PM and PM-FVW.

Even though FAN and TAN were elevated in PM and PM-FVW, the anaerobic process was not inhibited. Probably, the tolerance to high concentrations of nitrogen compounds was due to the use of acclimated bacteria to these substrates.

	pH	α	VFA/TA	VS $_d$(%)	COD $_d$(%)	TKN (g/l)	TAN (g/l)
PM-FVW	7.44 ± 0.32^a	0.84 ± 0.06^a	0.10 ± 0.04^a	64.94± 8.91^a	65.07 ± 3.22^a	3.16 ± 0.72^a	2.55± 0.16^a
PM	7.55 ± 0.23^a	0.85 ± 0.06^a	0.11 ± 0.06^a	58.47 ± 7.36^a	62.72 ± 17.4^b	4.36 ± 0.33^b	3.38 ± 0.33^a
CM	6.70 ± 0.31^b	0.80 ± 0.1^b	0.18 ± 0.07^b	40.59 ± 10.6^c	21.36 ± 6.73^c	1.12 ± 0.21^c	0.19 ± 0.03^b

Table 1. Average values of indicators (pH, α, VFA/TA) volatile solids destroyed (VS_d), chemistry organic demand destroyed (COD_d), total Kjeldhal nitrogen (TKN) and total ammonia nitrogen (TAN); α= partial alkalinity (PA) pH 5.75/total alkalinity (TA) pH 4,3. Same letters indicate not significant differences (p< 0.05).

STABLE CONDITIONS | ELEVATED ORGANIC MATERIAL REMOVAL EFFICIENCY | HIGH VALUES

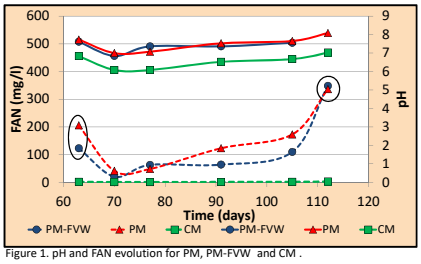


Figure 1. pH and FAN evolution for PM, PM-FVW and CM .

The biogas and methane production were 23 % and 19% higher in PM-FVW than PM , respectively (table 2).

The biogas yield in PM-FVW reached stable conditions after 60 days and had a better performance than PM and CM (Figure 2). Moreover, the biogas yield in PM decreased from that day to the end of the experiment. This behavior, could be related to increase of FAN values on the same period.

The highest methane yield (l CH_4/gVS added) was found in PM-FVW (0.21±0,01 for PM-FVW, 0.16 ± 0,03 for PM and 0.08 ± 0,02 for CM). All treatments showed stable methane yields during the evaluated period (Figure 3). However, a drop on the methane yield in PM was observed at 114 d. This effect could be related to the highest FAN concentration in PM registered at that time.

On the other hand, CM presented the lowest biogas and methane yield. Lower percentages of VS destroyed in CM could be owed to the presence of difficult to degrade compounds such as fiber and lignin.

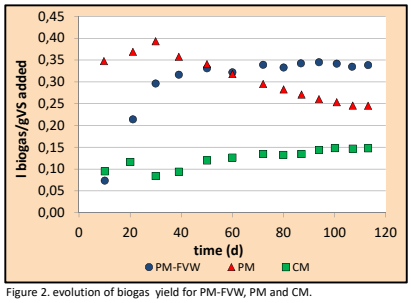


Figure 2. evolution of biogas yield for PM-FVW, PM and CM.

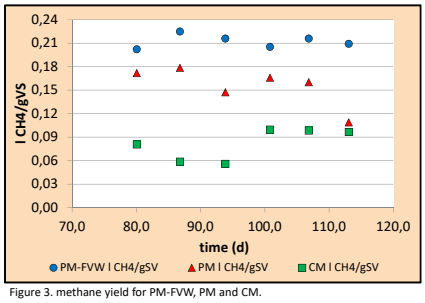


Figure 3. methane yield for PM-FVW, PM and CM.

	biogas (l)	methane (%)	methane (l)
PM-FVW	996.36	63.1	615.86
PM	764.16	63.2	498.36
CM	338.48	63.7	221.84

Table 2. Accumulated biogas and methane production and percentages of methane for PM-FVW, PM and CM .

CONCLUSION

These results showed that co-digestion of PM with fruit and vegetable in a ratio of 1:1 improved biogas and methane yield.

The high concentrations of FAN in mono-fermentation of poultry manure affected on the biogas and methane yield. The use of acclimatized bacteria avoided the inhibition of the process by high concentrations of nitrogen compounds.

The periodic physicochemical analysis on slurries and the monitoring of biogas generated are key tools to evaluate the efficiency and stability of the anaerobic process.

CONTACTS

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