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Biogas production by co digestion of animal manure and olive oil wastes

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Abstract: Anaerobic co-digestion is well established process for treating many types of organic wastes, both solid and liquid and evaluated for biogas (methane) production. The biogas production and some biochemical parameters of anaerobic digestion at 30°C for 40 days were studied for two sets of fermentation media, as affected by two factors: (1) the type of the animal waste pigeon waste, P and rabbit waste, R, and (2) the ratio of animal waste to olive cake which constitute four levels (100:0 for R1 and P1; 80:20 for R2 and P2; 60:40 for R3 and P3 and 40:60 for R4 and P4). The results indicated that there was a decrease in total gas production in the digesters of pigeons and highest production in the first week of the experiment for all digesters, but in experimental groups of rabbit wastes R1 (100:0) the highest production between 29-40 day and the others in the first week only. It is concluded that co-digestion of olive wastes, together with local agricultural residues, such as manure, is a sustainable and environmentally-attractive method to treat wastes and thus convert them from a burden to society to a useful resource. The biogas produced can be used for the generation of heat and/or electricity.

Key words: Anaerobic digestion, biogas, olive cake, animal wastes.

INTRODUCTION

Animal and agricultural wastes constitute a high proportion of biomass and their utilization and recycling is important for economical and environmental aspects.

Anaerobic digestion one of the most widely used processes for treating these wastes and represents an attractive method for treating organic wastes for biogas production as alternative energy sources (1-5).

Anaerobic digestion is the natural breakdown pathway of organic materials into methane and carbon dioxide gas and fertilizer. This process takes place naturally or in an anaerobic digester and presents an attractive treatment solution for high strength wastewaters due to the operational economy and generation of biogas with pollution decreasing at the same time. Anaerobic digestion is considered as one of the best technologies for treating industrial wastewater with a high organic load, which also controls malodorous emissions and stabilizes the biomass prior to its agronomic use (6-8).

Olive cake and some other residues such as cotton plant stalks and tree trimmings caused the presence of high amounts of lignocellulosic materials which have low digestibility. Organic olive cake in addition to animal wastes can be used as a source of fermentable organic matter in biomass technologies for biogas production (8-13).

Other benefits of co-digesting multiple waste streams include the improvement of nutrient balance and digestion, equalization of particulate, floating, settling, acidifying, etc. wastes, through dilution by manure or sewage sludge, additional biogas production, possible gate fees for waste treatment, additional fertilizer (soil conditioner) reclamation and more efficient use of equipment as well as cost sharing by processing multiple waste streams in a single facility (14 & 15).

This study was aimed at carrying out an anaerobic treatment of different proportions of mixtures of rabbit and pigeons wastes and olive oil solid wastes to obtain a certain volume of combustible gas that could partly solve the energy demands of the farm and to obtain an effluent with a lower polluting power and a higher fertilizers value than the fresh waste.

MATERIALS & METHODS

Rabbit and pigeon wastes were collected from rabbit- and pigeon-farms. Olive cake, which is a by-product of the olive industry, was collected from a local factory employing a hydrolic press and utilizing water and high centrifugation in the extraction process. Each waste was oven-dried separately at 45 °C and ground at 2.5 mm diameter.

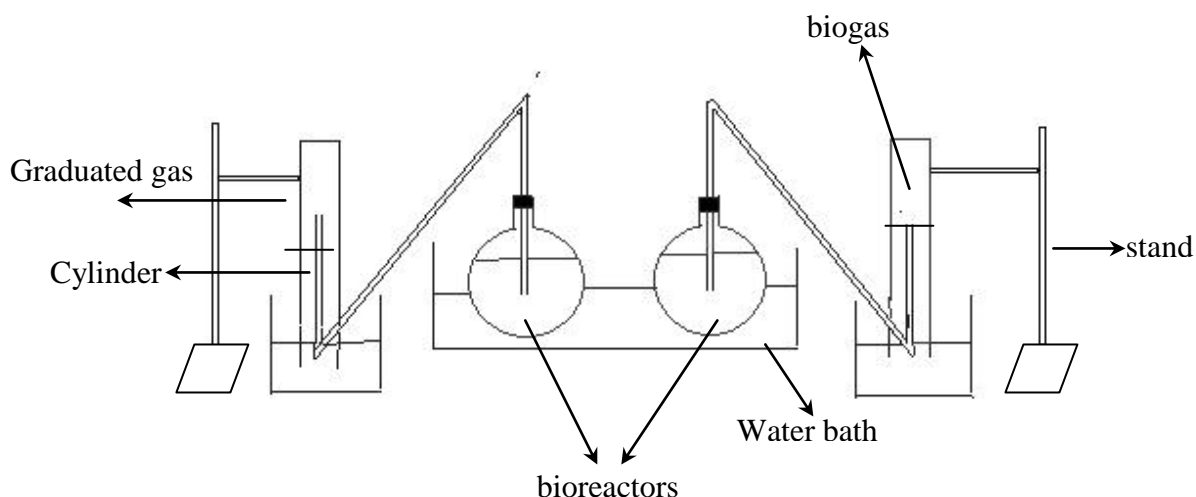


Figure (1) The experimental set up of biogas production and collection.

A factorial type completely randomized design was used in this study. The two factors were:

1. The type of animal waste (feces without urine rabbits R and pigeon P).
2. The ratio of waste to olive cake (dry wts) which constituted the following four levels : 100:0 (80g:0g) for R1 and P1 ; 80:20 (64g:16g) for R2 and P2 ; 60 : 40 (48g:32g) for R3 & P3 and 40:60 (32g:48g) for R4 & P4 (**Tables 1-3**).

Each set is carried out using four insulated anaerobic digesters, one for each of the experimental

groups of fermentable material tested. Each digester consisted of 1150 ml glass reaction bottle, having a working volume of 1000 ml and containing tap water (unless otherwise is mentioned) plus 8% (w/v) of total solids (80g). The retention period of the experiment was 40 days. The digesters were intermittently stirred and maintained at 30 °C in the water bath (Fig. 1). The daily gas production was measured by water displacement at atmospheric pressure (Fig. 1).

RESULTS AND DISCUSSION

Table 1 Anaerobic digesters of pigeon waste with different ratios of olive cake in distilled water.

Pigeon waste /olive cake (g)	Biogas production(ml)										Total biogas production (ml)
	Day										
	1	2	3	4	5	6	7	8-21	22-28	29-40	
100/0 (80g:0g)	390	650	200	120	70	45	25	100	170	280	2050
80/20 (64g:16g)	330	375	120	80	40	30	20	70	120	170	1355
60/40 (48g:32g)	235	250	80	60	30	25	10	60	80	100	990
40/60 (32g:48g)	215	200	70	50	25	15	5	30	40	60	710

Table 2 Anaerobic digesters of pigeon waste with different ratios of olive cake in tap water.

Pigeon waste /olive cake (g)	Biogas production(ml)										Total biogas production (ml)
	Day										
	1	2	3	4	5	6	7	8-21	22-28	29-40	
100/0 (80g:0g)	1225	1450	220	25	145	20	5	200	410	1500	5200
80/20 (64g:16g)	900	525	335	10	15	5	15	50	100	300	2255
60/40 (48g:32g)	559	500	375	100	40	10	5	20	50	110	1769
40/60 (32g:48g)	185	500	370	55	20	10	10	10	25	60	1245

Table 3 Anaerobic digesters of rabbit waste with different ratios of olive cake in tap water.

rabbit waste /olive cake (g)	Biogas production(ml)										Total biogas production (ml)
	Day										
	1	2	3	4	5	6	7	8-21	22-28	29-40	
100/0 (80g:0g)	50	50	40	25	40	10	20	280	690	4885	6023
80/20 (64g:16g)	325	40	30	18	15	10	10	120	350	2500	3408
60/40 (48g:32g)	275	25	15	10	5	5	5	80	250	180	2470
40/60 (32g:48g)	235	22	12	8	10	25	5	30	120	750	1217

As shown in **Tables 1-3** gas production decreased with increasing the amount of olive cake in the fermentation media containing either pigeon or rabbit wastes which agree with the previous results with different animal wastes (2, 3 & 16). This could be attributed to the high amount of lignocellulosic materials and lignin in olive cake with low digestibility (17).

Gas production during the whole experimental period decreased significantly in the P4 treatment compared with the P1 treatment (**Tables 1&2**) and in R4 treatment compared with the R1, R2 and R3 treatments upon increasing the olive cake proportion in the fermentation media (**Table 3**). Also, the results indicated that there was a significant decrease in the gas yield for the R2, R3 and R4 treatment when compared with the P2, P3 and P4 (**Table 2&3**), reflecting an effect induced by the type of animal waste (2).

Olive wastes has a very low nitrogen content, a constituent however which is needed by microorganisms for their growth at a concentration depending on the organic matter in the feed. Lipids and polyphenols, especially the long-chain fatty acids and phenolic compounds of the C-7 and C-9

phenylpropanoic family that are contained in olive wastes are difficult to be degraded by microorganisms or may inhibit certain microbial groups (3 & 18).

The degradation rate of nitrogen and energy consumption decreased which may imply that the microorganisms were less active in the digesters containing the higher proportion of olive cake. This is most probably due to a shortage of fermentable organic matter available in the fermentation media, a shortage induced by the increased levels of lignocellulosic materials, which have a low degradation rate (2 & 18).

CONCLUSIONS

Anaerobic processes have been widely used over the past decades for the treatment of industrial, agricultural and municipal wastewaters as well as for solid waste.

Co-digestion of olive wastes, together with local agricultural residues, such as manure, is a sustainable and environmentally-attractive method to treat wastes and thus convert them from a burden to society to a useful resource. The biogas produced can be used for the generation of heat and/or electricity.

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