Microbiolog cal studies on anaerobic digestion of solid and liquid wastes

Yasser Saad Ahmed EI-Akshar

Energy is needed daily in several purposes such as lightening, cooking and machines operation. The possibility of using the biological process of anaerobic digestion to reconcile the conflecting needs of both energy and manure from the same organic sources such as crop residues, animal and human wastes and food processing wastes has stimulated renewed worldwide interest in biogas digesters.The present study on biogas production via the anaerobic digestion of Jew's mallow and Artichoke processing wastes was carried out in two experiments:1-Biogas generation from Jew's mallow processing wastes (JMPW) and cattle dung (CD) by using batch feeding system.2-Biogas production from Artichoke processing wastes by using semi-continuous feeding system.Obtained results from the first experiment are summarized as follows: -1-Counts of anaerobic saccharolytic bacteria either hetero or homo-fermentative were gradually decreased during the first 21 days then rapidly decreased till the end of the experiment. This was true in digested slurries of JMPW and cattle dung.2-Populations of anaerobic proteolytic bacteria were higher in digested slurry of JMPW than the digested slurry of cattle dung (CD).3-Populations of anaerobic cellulose decomposers were gradually increased throughout the experimental period to reach their maximum records at the 14th and 21st days for JMPW and CD, respectively.4-Counts of anaerobic acid producing bacteria were gradually increased with the increasing of fermentation period and reached their maximum records at the 21' day and gradually decreased thereafter till the end of the fermentation course.5-Populations of anaerobic acid producing bacteria were parallel with the populations of anaerobic cellulose decomposing bacteria that provide simple sugars for acid producing bacteria. This was observed in the two organic wastes under investigation.6-Populations of different investigated pathogenic bacteria were rapidly decreased with the progress of the fermentation period. The colonies of total coliform bacteria were not detected at the 35th day sample and this was true in the two wastes under investigation. The undetection of fecal coliform bacteria was achieved at the and 35th days forJMPW and cattle dung, respectively.7-The counts of Salmonella & Shigella bacteria were rapidly decreased throughout the anaerobic digestion period to be completely undetected at the 14th and 28th days for JMPW and cattle dung, respectively.8-Volatile fatty acids concentrations increased by increasing the fermentation period to reach their maximum values at the 21" day. This was true for JMPW as well as CD. Moreover, the digested slurry of JMPW exhibited higher records for the concentrations of VFA as compared to the digested slurry of CD.9-The concentrations of NH4-N were gradually increased by increasing the fermentation period. The same trend of results was obtained in the two organic wastes under consideration. The accumulation of ammonia during anaerobic fermentation of either JMPW or CD did not reach the levels reported to be toxic or even inhibitive to methanogenic bacteria.10-The pH values in the digested slurry of the two organic wastes under study were decreased with the increasing of fermentation periodup to the 21 St day. pH values were increased thereafter till the end of the experimental period and this was true in both digested slurry of JMPW and cattle dung.11-The losses percentage of both total and volatile solids were higher in case of JMPW than CD.12-The percentages of macro and micro-elements in the digested slurries of JMPW and CD were increased at the end of the fermentation period. This increase is likely to be due to the consumption of volatile solids during anaerobic digestion to produce gases (CH4 and CO2).13-The

daily biogas production using JMPW was high at the beginning up to the fifth day, then decreased and showed fluctuation thereafter. High peak of biogas production was observed at the 18th day. On the other hand the produced gas from anaerobic digestion of CD was low at the beginning, then increased thereafter and showed fluctuation. Also, the daily biogas production from the digestion of cattle dung showed sligh a decrease after the 16th day up to 30 days. Thereafter, daily biogas production rapidly decreased with the increasing of fermentation period to reach a minimum level at the end of fermentation time. The cumulative biogas yield was higher in case of JMPW than cattle dung.14-The daily methane production either L / D / day or L / L / day generally showed an increase up to about 16-19 days and 19-23 days of fermentation period for JMPW and CD, respectively. Cumulative methane production during anaerobic digestion were higher in case of JMPW than CD and this result was observed all over the experimental period. 15-The methane percentage in the produced biogas was gradually increased with the increasing of fermentation period to reach its maximum values at the 27th and 30th day for JMPW and CD being 73.1% and 75% respectively. On the other hand, carbon dioxide percentages of the produced biogas were gradually decreased with the increasing of fermentation period to reach their minimum percentage at the 27th and 30th day for JMPW and CD being 26% and 23.4%, respectively.16- The biogas and methane production rates based on either total solids or volatile solids added or consumed were higher in the case of JMPW than cattle dung. Obtained results from the second experiment are summarized in the following : 1-Populations of hetero and homo-fermentative saccharolytic bacteria were higher records at 20 days HRT than either 30 or 40 days HRTs. In addition, counts of anaerobic saccharolytic bacteria (hetero and homo) were higher records during the first fermentation turn than either the second or the third turn of fermentation course.2-The highest counts of anaerobic proteolytic were observed during the first turn of fermentation at 20 days HRT. While, the counts of anaerobic proteolytic when the HRT was 30 or 40 days were almost similar at various determination periods since the counts of anaerobic proteolytic bacteria were slightly differed.3-The counts of anaerobic cellulose decomposers were gradually increased with the increasing of anaerobic digestion period during the first turn when the feeding rate was 2 liter / day and 20 day HRT. On the other hand, the counts of these bacteria were lower at 30 or 40 days HRT than the counts recorded at 20 days HRT.4-The highest counts of acid producing bacteria were observed at 20 days HRT and feeding rate 2 liter / day. While, the lowest counts of acid producing bacteria were observed at 40 days HRT and feeding rate 1 liter / day. In adEion, the counts of acid producers were higher during the first turn of fermentation than either the second or the third turns of fermentation. The same trend of results was observed at three hydraulic retention times under consideration. 5-The highest concentration of VFA during anaerobic digestion of Artichoke processing wastes was obtained when the HRT and feeding rate were 20 days and 2 liter / day, respectively. While, the lowest concentration of VFA was obtained when the HRT and feeding rate were 40 days and 1 liter / day, respectively. Except for 40 days HRT, VFA records were higher during the first turn of anaerobic digestion as compared to the second and third fermentation turns.6-The concentrations of ammoniacal nitrogen were gradually increased with the increasing of fermentation period. This was true during each fermentation turn as well as at different hydraulic retention times.7-The pH values were increased with the increasing of fermentation course. The same trend of results was observed at three hydraulic retention times under study. Moreover, obtained data in this study showed a pH range which is favourable to biogas generation and methane production.8-The concentration of total nitrogen, total phosphorus and total potassium as well as micro-elements (iron, zinc, manganese and copper) were higher at the end of the fermentation period as compared to the initiation one.9-Generally, the percentages loss in total and volatile solids were increased with the increasing of hydraulic retention time. This result was observed at three anaerobic digestion turns. On the other hand, the percentages loss of total and volatile solids were higher during the second and third fermentation turns than the losses observed during the first fermentation turn.10-Daily biogas production was slightly differed since it was almost similar during the fermentation course. The same trend of results was observed at different hydraulic retention times and various fermentation turns the overall rates of biogas production from the fermented wastes were decreased with the decreasing of the daily feeding rate. The highest rates of biogas production were observed during

the first turn of fermentation and this was true at various hydraulic retention times. 11-The daily methane production either liter / digester / day or liter / liter / day was higher records at 20 days HRT than that observed at 30 and 40 days HRTs. This trend of results was observed throughout the different fermentation turns.12-Respecting the methane percentage, the average methane percentage was higher at 20 days HRT as compared to the methane percentages that observed at 30 and 40 days HRTs.13-The highest rates of biogas and methane production per kg volatile solids either added or consumed were observed during the first fermentation turn. whereas, the lowest rates of biogas and methane production were observed during the third fermentation turn. The biogas and methane production rates were higher at 20 days HRT than other hydraulic retention times under study.