Chapter VI

SUMMARY

An intensive investigation was carried out to study the recycling of tannery biosludge and fleshing through biomethanation at Gandhigram Rural University, Gandhigram. The salient findings of the investigation are summarized in this chapter.

The fleshing from leather industries and biosludge from CETP (Common Effluent Treatment Plant) consist mainly of carbohydrates, proteins, lipids and inorganic materials. Tannery solid wastes (biological sludge and fleshing) were first analyzed for their physico-chemical composition. The concentration (g %) of nitrogen in tannery biosludge was 3.80 and in fleshing was 3.27. The concentration (g %) of phosphorus was low in tannery biosludge 0.09 and high in fleshing 0.26. The concentration (g %) of potassium was low in tannery biosludge 0.40 and high in fleshing 0.52. The concentration (g %) of organic carbon was low in tannery biosludge 15.6 and high in fleshing 32.2. High C: N ratio was recorded in fleshing as 8.5:1 and low C: N ratio was recorded in tannery biosludge as 4.1:1 and optimum C: N ratio in cowdung was 19.5:1. Based on nutritional content and availability of the feedstock materials, proteins and fat content were also analyzed in fleshing and it contains 7.2 % proteins and 11.0 % fats.

The objective of the present investigation is to accelerate the raw fleshing digestion by inoculating with efficient proteolytic and lipolytic bacteria, before subjecting to biomethanation. Screening of proteolytic and lipolytic bacterial isolates at different locations exhibited higher number of proteolytic bacterial strains in tannery-polluted soil and the number of lipolytic bacterial strains was higher in beam house sample. Among the total microbial colonies isolated from various locations, ten strains were screened for
proteolytic activity and based on the ability to release free amino acid two strains were selected. Similarly, nine strains were screened for lipolytic activity and based on the ability to release free fatty acid two strains were selected for further studies.

The proteolytic and lipolytic activity were assayed with treatments having varying pH viz., 5.0, 6.0, 7.0, 8.0 and 9.0 and varying temperature viz., 25°, 37° and 42° C. incubation with single strains and in combinations. The best proteolytic activity was recorded when raw fleshing was incubated with \textit{Bacillus subtilis} and \textit{Pseudomonas fluorescencer} subjected to pH 5. Free amino acid of 262[ig/ml was liberated within 24 hours of incubation. Similarly, the best lipolytic activity was recorded when raw fleshing was incubated with \textit{Bacillus cereus} and \textit{Pseudomonas aeruginosa} subjected to pH 8 and pH 9. Free fatty acid of 0.18 mg/ml was liberated within 24 hours of incubation.

Based on the experiments conducted, the optimum conditions for biological liquefaction was standardized before using as a feedstock for biomethanation.

In the second phase, investigations were carried out using raw and liquefied fleshing mixed with biological tannery sludge, cowdung and water for biogas production. The average gas production was 112 ml and methane content (74%) in T₅ treatment (raw fleshing: biological sludge:: 3:2) was slightly higher than T₀ treatment (cowdung: water:: 1:1) in terms of methane content (68 %) and gas production (102 ml). The results obtained by recycling liquefied fleshing and biological sludge through batch fermentation resulted good in average gas production in (T₅) with 143 ml and methane content of 80 % followed by (T₄) 3:1 with 121 ml gas production when compared to control (To) with 102 ml. Results indicated that the biologically liquefied tannery fleshing has enhanced gas productions as well as improved the methane content.
Parameters such as acetic acid concentration, reduction of COD, percentage of TS and VS reduction, reduction of organic carbon, percentage of NPK content of the digested slurry and change in pH were monitored. There is more production as well as utilization of acetic acid in the digester (T5) with liquefied fleshing (2.4g/l reduced to 0.2g/l). High concentration of acetate can be inhibitory to methane production; results revealed that methane formation is linearly related to acetate utilization. Methane production is a direct result of COD reduction within the methanogenic system. The COD within the digester (T5) reduced drastically with liquefied fleshing (3115 mg/l reduced to 325mg/l). Similarly, there was high percentage of Total Solids and Volatile Solids deacetylation in the treatment (T5) with liquefied fleshing i.e., 86 % and 75 % respectively. Percentage of carbon reduction was also high in the digester (T5) using liquefied fleshing i.e., 17.9 % reduced to 11.3 %. The NPK content of the digested slurry and changes in pH before and after digestion were also monitored. Results revealed that the NPK content of the treatment containing Liquefied fleshing is higher than the treatment containing raw fleshing. Initial pH of the slurry was 8.2 and after digestion, it has been reduced to 6.8 in the case of liquefied fleshing. The results obtained in the studies involving raw fleshing were lower in all parameters.

The results obtained in the studies revealed that parameters analysed during biomethanation was significantly (P<0.05 and PeO.01) higher in the T5 treatment than those observed in control and other treatments (T0 to T4). Furthermore, statistical analysis supported that the T5 treatment using liquefied fleshing as a feedstock was the best treatment.
The present study justifies liquefaction of tannery fleshing by inoculating the selected proteolytic and lipolytic bacterial strains. The isolates tested in the present investigation were well adapted to the liquefaction of tannery fleshing which could be effectively used for higher rate of biomethanation. It also reveals that the tannery solid wastes such as fleshing and biological sludge can be efficiently recycled through biomethanation. Thus, these hazardous wastes can be judiciously used as a potential organic waste for methane production. The present study strongly suggests that this relative simple biological treatment of leather waste may provide a practical and economical solution for the leather industries. Recycling these wastes through biomethanation yields biogas and the biosolids residue after anaerobic digestion is rich in nutrients, which could be used as an organic fertilizer in agriculture.