ABSTRACT

The objective of the current study was to evaluate the environmental impact and economic costs of producing bio-energy and bio-fertilizer utilizing anaerobic digestion from industrial waste water. A case study was carried out on a bioenergy production facility in the Pakistani city of Lahore that involved the collection of raw materials, the transportation of waste water, and the production of bioenergy and bio-fertilizer using a gate-to-grave methodology for environmental and economic examinations by life cycle assessment and life cycle cost methods. A midpoint method was used to evaluate the normalized results from the inventory data in the Gabi software, which highlighted the major factors that contributed to the overall environmental impacts, including eutrophication, water, ozone layer depletion, global warming, terrestrial eco-toxicity, and others. The results of the key phases demonstrate that the raw materials contributed significantly to the industrial waste water (IWW) life cycle in excess of 48%, compared to less than 25% for the phases of transportation, energy, and manufacture. The production of bioenergy and bio-fertilizer should be developed with an emphasis on the extraction of methane and carbon dioxide. Sensitivity analysis findings demonstrated that limiting methane and carbon dioxide should be a top focus for ecologically friendly production. Additionally, the results of the economic analysis showed that the production of bioenergy required a total investment of 948.85 PKR/t, and the manufacture of bio-fertilizer required a total investment of 885.50 PKR/t, with employee and personal salaries accounting for 75% of the total investment. These assessments led to several potential recommendations, such as bettering raw materials, industrial waste water procurement methods, operating procedures, or peer reviews. Moreover, IWW firms should expand their bioenergy production on a larger scale. This integrated assessment may be helpful in implementing green projects and in helping stakeholders who are concerned about balancing environmental sustainability with economic viability make decisions.