不同總固體濃度下雞糞厭氧消化之產氣特性

Gas Production Characteristics of Anaerobic Digestion of Chicken Manure under Different Total Solids Concentrations

工業技術研究院中分院

副工程師	副工程師	正工程師
簡睿廷	林彥伶	李志杰
Jui-Ting Chien	Yan-Ling Lin	Chih-Chieh Li

摘　要

雞糞過往常以生糞形式直接施用於農田，然而未經腐熟的雞糞易造成異味逸散與蒼蠅孳生等環境問題；而堆肥處理雖可改善上述情況，卻存在處理時間長、佔地需求大等缺點，降低農民使用意願。因此，本研究嘗試應用厭氧消化技術於雞糞處理，期望在穩定去化有機質的同時，額外產生具能源價值之沼氣，提升處理效益。

本研究旨在探討雞糞於不同總固體濃度（Total Solids, TS）條件下之厭氧消化過程產氣特性，透過測量甲烷濃度與產氣量隨時間之變化，並輔以水質參數進行綜合分析。試驗設計分為三組：（1）現場厭氧反應槽混合液體作為控制組（TS<5%）；（2）以反應槽出流水混合雞糞與厭氧污泥，調整 TS 至 5%；（3）同樣方式調整 TS 至 10%。每組皆設置兩重複樣本，一組用以監測沼氣產量與水質參數，另一組則用於甲烷濃度變化分析。試驗採批次操作，進行 28 天厭氧消化反映，並於反應前、兩次中期與反應結束時進行液相取樣，分析化學需氧量（Chemical Oxygen Demand, COD）、pH、氧化還原電位（Oxidation-Reduction Potential, ORP）及銨氮（NH_4^+-N）等水質指標。

試驗結果顯示，控制組於反應期間產生最高甲烷濃度，峰值達 44.4%；TS 5%組次之，TS 10%組最低。沼氣產量方面，控制組與 TS 5%組相近，平均每日每公升反應槽產氣量為 768 mL，TS 10%組為三組最低。整體而言，實驗組中低 TS 濃度（5%）條件在兼顧水質穩定與氣體產能方面表現最佳，而過高 TS 濃度（10%）可能抑制產甲烷菌活性，降低甲烷生成效率。

本研究結果可作為雞糞資源化處理與厭氧消化系統設計及操作管理之參考，亦有助於未來禽畜糞污處理流程之改良與應用推廣。

關鍵詞：雞糞，厭氧消化，沼氣產能

Abstract

Chicken manure has traditionally been applied directly to farmland in its raw form; however, untreated manure often leads to environmental issues such as odor emissions and fly infestation. While composting can mitigate these problems, it typically requires long processing times and substantial land area, which reduces its appeal to farmers. Therefore, this study explores the use of anaerobic digestion technology for treating chicken manure, aiming to not only stabilize and reduce organic matter but also produce biogas with energy value to enhance overall treatment efficiency.

This study investigates the gas production characteristics of anaerobic digestion of chicken manure under different total solids (TS) concentrations. Methane concentration and cumulative gas production were monitored over time, supplemented by an analysis of water quality parameters. The experiment consisted of three treatment groups: (1) a control group using the mixed liquid from an on-site anaerobic digester (TS < 5%); (2) a group with TS adjusted to 5% by mixing effluent from the digester with fresh chicken manure and anaerobic sludge; and (3) a group adjusted to 10% TS using the same method. Each group included two replicates: one for monitoring biogas production and water quality, and the other for analyzing methane concentration changes. The tests were conducted in batch mode over 28 days, with liquid samples collected at the beginning, two intermediate time points, and at the end of the digestion process. The samples were analyzed for chemical oxygen demand (COD), pH, oxidation-reduction potential (ORP), and ammonium nitrogen (NH_4^+-N).

The results showed that the control group produced the highest methane concentration during the digestion period, with a peak value of 44.4%, followed by the 5% TS group, while the 10% TS group had the lowest. In terms of biogas yield, the control and 5% TS groups were similar, both averaging 768 mL of gas per liter of reactor volume per day, whereas the 10% TS group had the lowest yield among the three. Overall, the low TS concentration (5%) condition exhibited the best balance between water quality stability and gas production. In contrast, the high TS concentration (10%) likely inhibited methanogenic activity, resulting in reduced methane generation efficiency.

These findings can serve as a reference for the resource utilization of chicken manure and the design and operational management of anaerobic digestion systems. They may also contribute to improving and promoting future treatment processes for livestock and poultry waste.

Keywords: Chicken manure，Anaerobic digestion，Biogas production potential