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# Impact of the substrate loading regime and phosphoric acid supplementation on performance of biogas reactors and microbial community dynamics during anaerobic digestion of chicken wastes

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## HIGHLIGHTS

- Anaerobic digestion of chicken wastes under various conditions was investigated.
- Phosphoric acid at moderate level positively affected the anaerobic digestion process.
- 454 pyrosequencing approach was used to evaluate the microbial community diversity.
- *Bacteroidales*, *Erysipelotrichaceae*, *Clostridium*, *Methanosarcina* were the abundant taxa.
- The major process parameter shaping community structure was the high ammonia level.

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## ABSTRACT

This study evaluates the effects of increasing organic loading rate (OLR) and decreasing hydraulic retention time (HRT) as well as phosphoric acid addition on mesophilic reactors' performance and biogas production from chicken wastes. Furthermore, microbial community composition in reactors was characterized by a 16S rRNA gene-based pyrosequencing analysis. Each step of increasing OLR impacted on the activity of microorganisms what caused a temporary decrease in biogas production. The addition of phosphoric acid resulted in the increased biogas production with values between 361 and 447 mL $g_{VS}^{-1}$ from day 61 to day 74 compared to control reactor (309–350 mL $g_{VS}^{-1}$). With reactors' operation, *Bacteroidetes* phylotypes were noticeably replaced with *Firmicutes* representatives, and significant increase of *Clostridium* sp. was identified. Within *Euryarchaeota*, *Methanosarcina* sp. dominated in all analyzed samples, in which high ammonium levels were detected (3.4–4.9 $NH_4^+$-N g $L^{-1}$). These results can help in better understanding the anaerobic digestion process of simultaneously ammonium/phosphate-rich substrates.



## 1. Introduction

Anaerobic digestion has received significant importance within the last 20–30 years. Biogas as a representative of renewable energy sources can be obtained via biological degradation of various organic waste materials (e.g. agricultural residues and municipal solid wastes) under anaerobic conditions. This anaerobic process leads to organic waste utilization simultaneously with the energy generation, thus solving society's most urgent needs, effective wastes disposal and alternative clean energy production. Research activities in the field of anaerobic digestion processes have recently received much attention, particularly focusing on the influence of different operational and environmental parameters on different types of biogas reactors' performance, optimization of anaerobic digestion processes and microbiology of anaerobic digesters (Niu et al., 2013a).

Anaerobic treatment of poultry manure is more problematic than anaerobic digestion of manure from other farm animals, since poultry wastes contain high amounts of nitrogen and their anaerobic conversion can result in ammonia inhibition process. Anaerobic digestion of chicken wastes with high content of uric acid and undigested proteins results in the production of toxic un-ionized free ammonia ($NH_3$, FAN) and ionized ammonium ions

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