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Optimization of hydrolysis conditions for minimizing ammonia accumulation in two-stage biogas production process using kitchen waste for sustainable process development

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ABSTRACT

Accumulation of ammonia produced by deamination of proteins during anaerobic digestion of kitchen waste for biogas production is a critical issue since ammonia is a potential inhibitor of biomethanation process. This work deals with optimization of hydrolysis for minimum ammonia accumulation by controlling the physico-chemical conditions viz. temperature, pH and aeration. The hydrolysis experiments were carried out using kitchen waste slurry (5% w/v) in an agitated fermenter of 1.5 L working volume. The study was conducted based on statistically designed experimental sets, to find out the optimum conditions required for maximizing ammonia removal during kitchen waste digestion. Preliminary screening experiments were carried out based on a full factorial design to get key information regarding the system performance and to further, extend into the Box-Behnken design for process optimization. The developed model had R^2 of 0.9677 and 0.9406 for % total and free ammoniacal nitrogen removal respectively. The results suggested minimized ammoniacal nitrogen accumulation during hydrolysis (net removal up to 75 %) with 3589±469 mg/L soluble COD and 1419 ±136mg/L TVFA concentration at pH 7.2 to 7.5, temperature 43 – 48˚C, Aeration 0.19 - 0.22 vvm. This leads to reduction in ammonia accumulation up to 66 % operated under optimized hydrolysis conditions compared to other operating condition in methanogenic phase. Operating the biogas digesters under these optimum conditions may help to overcome the problem of ammoniacal nitrogen accumulation during anaerobic digestion of kitchen waste for biogas production.

Keywords: Ammonia removal; deamination; food waste hydrolysis; statistical analysis; process optimization; aerobic treatment.

Introduction

Yearly, more than 130 million tons of food is wasted worldwide leading to the generation of an enormous amount of kitchen waste [1]. Kitchen waste has high organic nutrient contents and rapidly gets decomposed due to the microbial action causing bad smell and diseases which make kitchen waste management