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# Study on Biogas Production ofJoint Anaerobic Digestion with Excess Sludge and Kitchen Waste

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**Abstract**

Excess sludge from wastewater treatment plant and kitchen waste were mixed at different ratios to investigate the digestion process and efficiency in a joint anaerobic digestion system. The results showed that the efficiency of joint anaerobic digestion couldbe higher than that for pure excess sludge or pure kitchen waste, when the TS ratio of excess sludge to kitchen waste was 1:4.After the digestion of 66 days, the degradation rates of COD, TS and VS could reach 49.7%, 37.8% and 30.0% respectively, and the corresponding gas productions of TS and VS could reach 368mL/g and 677mL/g respectively.



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*Keywords:Excess sludge; kitchen waste; joint anaerobic digestion; biogas production;*

## Introduction

The acceleration of urbanization in China has resulted in continuous expanding of city scale, rapid growing of urban population and increasing production of municipal solid waste (MSW). According to recent statistics, the cities in China produced about 130 million tons of garbage every year, and it continued to increase at an average annual growth rate of 10%. MSW is the inevitable outcome of urban development, and will pollute the soil, water and air, and even harm people's healthas a long-standing source of pollution, if it is not addressed or handled properly (Bai*et al.* 2009).The characteristics of MSW in China are high in water content and high in organic matter content, nevertheless it would become a resource with the use of anaerobic digestion technology, reducing the

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pollutions and in the meanwhile producing methane, the clean energy (Li*et al.* 2014).

Kitchen waste is one of the largest waste stream and accounts for about 30% of the total MSW, and the anaerobic digestion as an environmentally friendly technology is capable of treating it. However, digestion process tends to fail or the digestion efficiency would be greatly limited when one readily degradable organic matter is used as sole substrate(Zhang*et al.* 2007;Ratanatamskul*et al.* 2014;Ratanatamskul*et al.* 2015) . Therefore, it would be better to mix different feed stocks to one joint anaerobic digestion system to improve the efficiency of waste digestion (Nathan*et al.* 2011; Wan*et al.* 2013;Madan*et al.* 2015). Excess sludge from wastewater treatment plant contains a lot of organic matter, N, P, K and bacteria of anaerobic digestion, and could serve as an appropriate substrate for anaerobic digestion (Athapol *et al.* 2007).

In this study, we would use excess sludge and kitchen waste as raw materials and mix them at different ratios to investigate the digestion process and efficiency by monitoring the pH, COD, TS, VS and the volume of biogas in a joint anaerobic digestion system, with a view to provide a theoretical basis for the engineering applications of joint anaerobic digestion technology.

## 1. Materials and Methods

### *1.1 Materials and Inoculum*

Kitchen waste used in this study was collected fromOrdos CityWaste TreatmentPlant, and the excess sludge and the inoculatedsludge was collected from theNorthern Suburb Sewage Treatment Plantof Ordos. The inoculatedsludge is acclimated asinoculumat the temperature of 35 ℃.

### *1.2 Experimental Set-up*

Experimental deviceis ahandmadedrainanaerobic digestion device, which mainly consists of anaerobic digestion bottles, draingas gathering bottles,compositionmeasurement waterbottles (1 L) etc.. Anaerobic digestion bottles and draingas gathering bottles are sealed by suitably sizedrubber stoppers with glasspipes. The bottles are connected with rubberpipes. The ligated digestion device is placedin a water bath set at a constant temperature of 35℃.

### *1.3 Test Method*

In this experiment, digestion substrates are prepared as “pure” excess sludge, “pure” kitchen waste and four mixings of the two with different TS ratios. Each of the six treatment groups has two replicates, adding in 30% of the inoculum. Anaerobic digestion tests are kept at 35 ℃, stirred daily. Sampling is conducted every three days, and the volume of produced biogas is measured every day at 10:00 am. The characteristics of the raw materials at different ES:KW ratios and the digestion conditions are shown in Table 1.

### 1.4 Measurements

COD is measured using the Fast Airtight Catalytic Method, the TS is determined by drying method, and the VS by burning method. pH is measured using pHS-3C digital precision pH meter, and the biogas production is determined with the drainage collection process by measuring the volume of water.

Table 1: Mixing ratios of excess sludge (ES) to kitchen waste (KW) and their characteristics

| Raw Materials ES： KW (TS） | pH | COD/(mg/L) | TS/% | VS/% |
|---|---|---|---|---|
| 0:5 | 7.27 | 57202.9 | 7.59 | 63.33 |
| 1:4 | 7.37 | 49735.8 | 7.59 | 54.33 |
| 2:3 | 7.5 | 46135.6 | 6.82 | 51.31 |