



The Tenth International Conference on Waste Management and Technology (ICWMT)

The content variation of fat, protein and starch in kitchen waste under microwave radiation

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Abstract

Kitchen waste may cause the environment pollution and threaten the humans' health. Simultaneously, it also has resourcing value. Fat, protein and starch are three main components in kitchen waste, which account for 80% in total. With the aim of facilitating the recycling of kitchen waste, it is important to effectively separate these three components from it. In this paper, microwave radiation has been used in the separation of these three components. The effects of time and temperature on the contents of these three components in kitchen waste were analyzed and the extraction process was discussed. The results showed that both time and temperature had significant influence on the contents of these three components. The content of fat was firstly increasing, then decreasing, and the contents of protein and starch were firstly decreasing, then increasing, which meant that protein and starch were firstly separated from the kitchen waste, followed by the separation of fat.

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Peer-review under responsibility of Tsinghua University/ Basel Convention Regional Centre for Asia and the Pacific

Keywords: kitchen waste; content variation; fat; protein; starch; microwave radiation

1. Introduction

Kitchen waste, generated in food production, transportation, distribution and consumption,¹ is a very broad concept including food residues and waste oil. Accounting for about 60% to 70% of municipal solid waste,² kitchen waste has become one of the most urgent problems worldwide because of its large quantity, wide generation and potential environmental hazards.³ In China, about 195 million tons of kitchen waste is generated per year.⁴ Since kitchen waste contains a lot of water and organics,⁵ it can encourage the growth of microorganism, thus promoting the spread of the disease if exposed in the air. Once this kitchen waste is eaten by animals, the disease can go into the bodies of human

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beings through the food chain. Besides, kitchen waste can generate offensive odors which may pollute the air and even the environment.⁶

On the other side, kitchen waste has a high content of organic matter. Among all the organic matters, fat, starch and protein are three main components in kitchen waste, which account for about 80% of the dry kitchen waste. All of the three can create recycling values. Fat can be a cheap feedstock for the production of biodiesel.^{7, 8} Starch can be converted into reducing sugars by hydrolysis.^{9, 10} Protein can be prepared for the production of high-purity animal feed.¹¹ However, the recycling process of each component will be influenced by other two components. For example, the fat in kitchen waste may inhibit the process of microbial methods and the hydrolysis of starch,¹ and high concentration of free ammonia (NH₃) resulting from degradation of protein components can prove toxic to the specific activity of methanogenic bacteria, causing serious effects to the recycling process.^{12, 13} So it is of great importance to separate the three components apart to obtain the maximum recycling value of kitchen waste.

Microwave separation technology is the highlighted research in recent years. Microwave is a kind of electromagnetic waves with the wavelength of 0.1mm~1mm. Microwave heating has many advantages over traditional heating in several aspects such as less heating time, strong penetration, overall heating, selective heating, etc.^{14, 15} However, this technology has not been so widely used in the separation of different components from kitchen waste. This paper investigated the content variation of fat, protein and starch in kitchen waste under microwave radiation, with a brief analysis of the extraction process of these three components.

2. Materials and method

2.1 Materials

Kitchen waste, as feedstock, is collected from Xiyuan Canteen of Tongji University. In order to get uniform samples, 42 samples were collected from Sunday to Saturday, which meant 6 samples per day including 3 lunch samples and 3 dinner ones. All the samples were dried, grinded and sifted. Then the composition of this kind of kitchen waste was measured by the Chinese National Standard. Results are shown in Table 1.

Table 1. Composition of food waste in Xiyuan Canteen of Tongji University

	Water content	Dry matter	Crude fats*	Crude protein*	Starch*	Others*
Average value (%w/w)	79.2	20.8	22.3	29.3	34.7	13.7

*Percentage in dry matter of food waste

All the chemicals used in experiments were purchased from Sinopharm Chemical Reagent Co., Ltd.

2.2 Method

The experimental process was conducted in a microwave reactor with a power of 1.2kW. 10.00g of samples and 300mL of deionized water were added in it. Then the reactor was sealed and heated to a selected temperature. The reaction was timed when the temperature reached the selected value. After the reaction, the samples were taken out for centrifugation at a speed of 8000rpm for 10min. The solid sample in the under layer was transferred to a constant-weight aluminum box. This box was then dried in an air-blower-drier at 105°C overnight. Then the contents of fat, protein and starch were measured by the following Chinese methods. (Table 2)

Table 2. Methods for the determination of components in kitchen waste

Components	Methods
Fat	GB/T 14772-2008
Protein	GB/T 5009.5-2003
Starch	GB/T 20378-2006

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