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Microbial conversion of food wastes for biofertilizer production with thermophilic lipolytic microbes

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Abstract

Food waste is approximately one quarter of the total garbage in Taiwan. To investigate the feasibility of microbial conversion of food waste to multiple functional biofertilizer, food waste was mixed with bulking materials, inoculated with thermophilic and lipolytic microbes and incubated at 50 °C in a mechanical composter. Microbial inoculation enhanced the degradation of food wastes, increased the total nitrogen and the germination rate of alfalfa seed, shortened the maturity period and improved the quality of biofertilizer. In food waste inoculated with thermophilic and lipolytic *Brevibacillus borstelensis* SH168 for 28 days, total nitrogen increased from 2.01% to 2.10%, ash increased from 24.94% to 29.21%, crude fat decreased from 4.88% to 1.34% and the C/N ratio decreased from 18.02 to 17.65. Each gram of final product had a higher population of thermophilic microbes than mesophilic microbes. Microbial conversion of food waste to biofertilizer is a feasible and potential technology in the future to maintain the natural resources and to reduce the impact on environmental quality.

Keywords: Biofertilizer; Food wastes; Maturity; Thermophilic and lipolytic microbes

1. Introduction

Food waste is approximately 17.94–27.76% of the total garbage in Taiwan [1–3]. It has a high moisture and organic matter content, which is easily decomposed by microbes.

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It produces odor detrimental to environmental quality. Direct landfill of food wastes has created various problems such as putrid smells and leachate polluting ground and surface waters, while incineration treatment has been restricted due to its low calorific value and the cost of fuel supplements for operation [3,4]. Recycling food wastes can benefit the environment by reducing the amount of garbage disposed, promoting the fertility of soil and improving the physical and chemical properties of soil [5]. Moreover, recycling of food wastes reduce the unpleasant odors of garbage, benefits the sanitation of the environment, and decreases garbage collection-related spending.

Food waste is less harmful to the environment than industrial waste. Thus, composting of food waste is attracting considerable attention because it would significantly reduce the amount of waste and the product can be used as compost or biofertilizer which can be handled, stored, transported and applied to the field without adversely affecting the environment [6]. Although various composters are currently commercially available or several types of in-vessel composting systems have been developed for installation in food service establishments to manage food waste as a recyclable resource, it is difficult to maintain steady degradation due to the instability of the microflora within the composter due to the raw material, pH, temperature and other environmental conditions [7–12]. Combining, food waste collection with mechanical composting and inoculation of thermophilic microbes to accelerate the composting has been examined. Food wastes were mixed with sawdust or waste leaves as bulking material, thermophilic microbes were inoculated and biofertilizer was prepared using the mechanical composter. The physical, chemical and microbiological properties of the biofertilizer were analyzed during the incubation. The effects of inoculant and raw material on the quality of biofertilizer were also investigated.

2. Materials and methods

2.1. Raw materials

Food wastes were collected from a National Taiwan University (NTU) restaurant. Despite daily variation of the menu in the restaurant, the compositions of food wastes changed only slightly in different batches as shown in Table 1. Waste leaves were also collected from the NTU Campus, and chopped to about 1 cm pieces using the composter in order to enhance the composting. Sawdust was purchased from the local market. Raw materials of food wastes were mixed with sawdust or waste leaves to adjust the initial moisture content 60–65% and the C/N ratio between 20 and 25.

2.2. Composter operation

The DY-8075E mechanical composter (Biorich Technology Corporation, Taiwan), having capacity of approximately 250 l was used. It has stainless steel blades for intermittent rotary agitation to ensure uniformity of the contents, a heating unit for the inner temperature and a heat sensor for monitoring the inner temperature.

The experiments were run under three different control regimes and the conditions are shown in Table 2. The first batch was run using the method provided by the Biorich Technology Corporation without inoculation, the second and third batches each with two bioreactors, were operated with inoculation, one with the thermophilic microbial