

1.Introduction

As population growth and living standards improve, the generation of food waste(FW) has steadily increased^[1]. Rich in moisture and organic matter, food waste has long been considered a material with potential for resource recovery^[2, 3]. Aerobic composting is one of the primary methods for treating food waste, utilizing naturally occurring microorganisms to break down complex organic molecules into stable humus under well-ventilated, thermally regulated conditions^[4]. Through controlled human intervention such as maintaining optimal moisture levels and a balanced carbon-to-nitrogen ratio conditions are optimized to enhance microbial activity and the transformation of organic matter, relying on the synergistic functions of bacteria, fungi, and actinomycetes^[5]. The use of organic waste as fertilizer has a history spanning thousands of years in human society. Even in ancient times, when productivity was limited, people recognized that materials like manure and food waste, if properly managed, could enhance crop yields. However, due to low population levels, there was an insufficient supply of organic waste available for use as fertilizer. In modern times, the invention of chemical fertilizers has led to substantial increases in crop yields. However, chemical fertilizers cannot be used excessively and must be supplemented with organic fertilizers to prevent soil compaction and other adverse effects on soil health. Organic fertilizers were traditionally derived from agricultural waste, livestock waste, and sludge, which often carried risks of heavy metal contamination^[6], antibiotic residues^[7], or resistant gene pollution^[8]. In recent years, food waste has emerged as a preferable source for organic fertilizer production due to its minimal contamination with such pollutants^[9]. Consequently, extensive research has been conducted to optimize the composting of food waste, leading to a well-developed process for producing organic fertilizers from this source. In addition, numerous studies have shown that land applications of resource products derived from food waste yield favorable results^[10].

Moreover, as global warming intensifies, carbon emissions from traditionally overlooked sectors and industrial processes are drawing increasing attention. Food waste management has emerged as a critical area of focus. Studies have highlighted

Supplementary material