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Isolation and characterization of a novel cinosulfuron degrading *Kurthia* sp. from a methanogenic microbial consortium

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ABSTRACT

A novel bacterial strain LAM0713 was isolated from a methanogenic bacterial complexes and identified as *Kurthia* sp. based on morphological, cultural, physio-biochemical characteristics and analysis of 16S rDNA sequence. Strain LAM0713 was found to be capable of utilizing cinosulfuron as sole nitrogen source for growth over a wide range of temperature (20–40 °C) and pH (5.0–9.0). Response surface methodology was used to optimize the degradation conditions. Strain LAM0713 could efficiently degrade 92.4% of initially supplemented 50 mg · L^1 cinosulfuron under the optimum conditions (pH 6.9, 31.8 °C) within 5 days. Five intermediates formed during cinosulfuron degradation were detected by liquid chromatography mass spectrometry (LC–MS), and a metabolic pathway for cinosulfuron degradation was proposed via cleavage of the sulfonylurea bridge. It is the first report showing that *Kurthia* sp. strain could degrade sulfonylurea herbicides, suggesting that strain LAM0713 may provide new insight into microbial degradation of herbicides.

1. Introduction

Sulfonylurea herbicides are widely used for weed control in cultivation of many crops, such as paddy rice, wheat, soybean, sugar beet, and maize. The action mechanism of sulfonylurea is to inhibit the acetolactate synthase (ALS), a key enzyme in the biosynthetic pathway of branched-chain amino acids in bacteria, fungi and higher plants, but absent in animals and human (Krynitsky, 1997; Sabadie, 2000). These chemicals have some advantages including high activity at low application rates (2–60 g/ha) in the field, broad action-spectrum, good crop selectivity and low mammalian toxicity (acute oral LD_{50} is generally >5000 mg/kg on rat) (Furlong et al., 2000).

Cinosulfuron (1-(4,6-dimethoxy-1,3,5-triazin-2-yl)-3-[2-(2-methoxyethoxy)phenyl-sulfonyl]urea) is a member of sulfonylurea, and specifically used for the control of broadleaf and cyperaceous weeds before or after their germination in rice paddy. This herbicide was introduced into China in 1994, and has been popularly used in the country (Fletcher et al., 1994). The fate and behavior of cinosulfuron in the environment has been previously investigated by some groups (Lee et al., 2002; Negre et al., 2005). Like other members of sulfonylurea, cinosulfuron can persist in soil for long time, giving significant damage to crops, affecting functional microorganism and enzymes in soil. This chemical showed lower degradation rate in aqueous acidic solution than other four sulfonylureas: thifensulfuron-methyl, metsulfuron-methyl, sulfometuron-methyl, and chlorsulfuron (Allievi and Gigliotti, 2001; Vulliet et al., 2002). Consequently, rapidly detoxification of the residua of cinosulfuron in the environment is considered to be an urgent issue.

Chemical hydrolysis and biological degradation are the primary degradation processes of herbicides in soil (Morre et al., 1995). Although chemical or microbiological degradation of some sulfonylurea herbicides, including sulfometuron-methyl, metsulfuron-methyl, chorsulfuron, thifensulfuron-methyl, rimsulfuron, amidosulfuron, and nicosulfuron, have been previously investigated (Hickes and Watrous, 1999; Martins and Mermoud, 1999), there is still a general lack of knowledge on bacterial degradation of cinosulfuron (Fenoll et al., 2012; Peng et al., 2010).

In this study, a novel cinosulfuron degrading *Kurthia* strain was isolated from a methane producing microbial consortium and

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