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Burkholderia ginsengiterrae sp. nov. and *Burkholderia panaciterrae* sp. nov., antagonistic bacteria against root rot pathogen *Cylindrocarpon destructans*, isolated from ginseng soil

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Abstract Strain DCY85^T and DCY85-1^T, isolated from rhizosphere of ginseng, were rod-shaped, Gram-reaction-negative, strictly aerobic, catalase positive and oxidase negative. 16S rRNA gene sequence analysis revealed that strain DCY85^T as well as DCY85-1^T belonged to the genus *Burkholderia* and were closely related to *Burkholderia fungorum* KACC 12023^T (98.1 and 98.0 % similarity, respectively). The major polar lipids of strain DCY85^T and DCY85-1^T were phosphatidylethanolamine, one unidentified aminolipid and two unidentified phospholipids. The major fatty acids of both strains are C_{16:0}, C_{18:1}ω7c and summed feature 3 (C_{16:1}ω6c and/or C_{16:1}ω7c). The predominant isoprenoid quinone of each strain DCY85^T and DCY85-1^T was ubiquinone (Q-8) and the G+C content of their genomic DNA was 66.0 and 59.4 mol%, respectively, which fulfill the characteristic range of the genus *Burkholderia*. The polyamine content of both DCY85^T

and DCY85-1^T was putrescine. Although both DCY85^T and DCY85-1^T have highly similar 16S rRNA and identical *RecA* and *gyrB* sequences, they show differences in phenotypic and chemotaxonomic characteristics. DNA–DNA hybridization results proved the consideration of both strains as two different species. Based on the results from our polyphasic characterization, strain DCY85^T and DCY85-1^T are considered novel *Burkholderia* species for which the name *Burkholderia ginsengiterrae* sp. nov. and *Burkholderia panaciterrae* sp. nov. are, respectively, proposed. An emended description of those strains is also proposed. DCY85^T and DCY85-1^T showed antagonistic activity against the common root rot pathogen of ginseng, *Cylindrocarpon destructans*. The proposed type strains are DCY85^T (KCTC 42054^T = JCM 19888^T) and DCY85-1^T (KCTC 42055^T = JCM 19889^T).

Keywords Taxonomy · Proteobacteria · *Burkholderia ginsengiterrae* · *Burkholderia panaciterrae* · Antagonistic activity

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The GenBank/EMBL/DDBJ accession number for the 16S rRNA, *gyrB* and *recA* gene sequence of strain DCY85^T and DCY85-1^T are KF915802, KF999960, KM501455, KM501454, KM495734 and KM495735, respectively.

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Introduction

The genus *Burkholderia* that belongs to *Burkholderiaceae* family (Sheu et al. 2013; Tian et al. 2013) was previously described as members of RNA homology group II of the genus *Pseudomonas*. (Yabuuchi et al. 1992). The genus *Burkholderia* comprises 89 species isolated from a wide range of niches (Coenye et al. 2004; Tian et al. 2013). Members of *Burkholderia* genus are gram-negative, aerobic, non-spore-forming, non-fermentative, straight rod-shaped and catalase-positive bacteria. Some strains are motile by using a single polar flagellum or a tuft of polar flagella (Gillis et al. 1995; Kim et al. 2006). *Burkholderia*