The taxonomic position of an actinomycete, designated strain IMMIB L-21T, was determined using a polyphasic taxonomic approach. The organism, which had phenotypic properties consistent with its classification in the genus *Nocardiopsis*, formed a distinct clade in the 16S rRNA gene sequence tree together with the type strain of *Nocardiopsis composta*, but was readily distinguished from this species using DNA–DNA relatedness and phenotypic data. The genotypic and phenotypic data show that the organism represents a novel species of the genus *Nocardiopsis*, for which the name *Nocardiopsis potens* sp. nov. is proposed. The type strain is IMMIB L-21T (=DSM 45234T =CCUG 56587T).

The genus *Nocardiopsis* was proposed by Meyer (1976) on the basis of chemotaxonomic and morphological characteristics. At the time of writing, the taxon encompasses 28 recognized species and 4 subspecies, which form a distinct clade within the evolutionary radiation occupied by members of the family *Nocardiopsaceae* (Rainey et al., 1996). *Nocardiopsis* strains are frequently isolated from saline soils (Yassin et al., 1993a; Li et al., 2004, 2006), but they have also been recovered from an alkaline slag dump (Schippers et al., 2002), indoor environments (Peltola et al., 2001), the atmosphere of a composting facility (Kämpfer et al., 2002) and clinical material (Bernetzche & Lebreux, 1991; Yassin et al., 1997). In the present polyphasic study, an actinomycete isolated from household waste was shown to represent a novel species of the genus *Nocardiopsis*.

Strain IMMIB L-21T was isolated from a household dustbin on Brain Heart Infusion (BHI; BD) agar, glucose-yeast-extract-malt extract agar (GYM; medium 65; DSMZ) and Columbia agar (BD) supplemented with 5% sheep blood. The organism was grown on yeast-extract-malt extract agar (ISP 2), oatmeal agar (ISP 3) and inorganic salts-starch agar (ISP 4) as described by Shirling & Gottlieb (1966) and examined for pigmentation and colour of aerial and substrate mycelia. Gram and Ziehl–Neelsen stains were applied to hyphae grown on Columbia agar. Growth at different temperatures was determined at 10, 20, 27, 37 and 42 °C and a range of phenotypic characteristics was examined using standard procedures.

The GenBank/EMBL/DDBJ accession number for the 16S rRNA gene sequence of strain IMMIB L-21T is FM253114.
DNA–DNA relatedness studies were performed between strain IMMIB L-21T, Nocardiopsis composta DSM 44551T and Nocardiopsis halophila DSM 44494T. DNA was isolated using a French pressure cell (Thermo Spectronic) and was purified by chromatography on hydroxyapatite as described by Cashion et al. (1977). DNA–DNA hybridization was carried out as described by De Ley et al. (1970) with consideration of the modifications described by Huß et al. (1983) using a model Cary 100 Bio UV/VIS-spectrophotometer equipped with a Peltier-thermostatted 6 × 6 multichannel changer and a temperature controller with an in situ temperature probe (Varian).

Strain IMMIB L-21T grew well on ISP 2–4, producing a pale-yellow to brown–yellow substrate mycelium that carried white aerial hyphae; diffuse pigments were not produced. Melanoid pigments were not produced on ISP 6 or ISP 7. The substrate hyphae fragmented into cocccoid-to-rod-shaped elements. The aerial hyphae bore chains of spores. The spores were elongated and had smooth surfaces. The hyphae were Gram-positive and non-acid-fast. The organism grew at temperatures up to 37 °C but not at 10 or 42 °C. The range of phenotypic characteristics are listed in Table 1 and the species description.

Chemotaxonomic studies revealed that strain IMMIB L-21T had a chemical profile consistent with its assignment to the genus Nocardiopsis. The strain was characterized by the presence of meso-diaminopimelic acid with no characteristic sugars in whole-organism hydrolysates (cell-wall chemotype III according to Lechevalier & Lechevalier, 1970). The respiratory quinones consisted of dihydrogenated, tetrahydrogenated, hexahydrogenated and octahydrogenated menaquinones with 9, 10 and 11 isoprene units [MK-11(H2,4,6,8), MK-10(H2,4,6,8) and MK-9(H2,4,6,8)] as the predominant menaquinones. The major phospholipids of strain IMMIB L-21T were phosphatidylcholine, phosphatidylethanolamine, diphosphatidylglycerol, phosphatidylglycerol, phosphatidylinositol and phosphatidylinositol mannosides (phospholipid type III according to Lechevalier et al., 1977). The fatty acid profile was dominated by iso- and anteiso-branched and 10-methyl-branched fatty acids. Traces of straight chain unsaturated fatty acids were detected. The principal components were anteiso-C13:0 (0.85 % of total fatty acids), iso-C14:0 (3.91 %), C14:0 (2.71 %), iso-C15:0 (5.34 %), anteiso-C15:0 (18.82 %), C15:0 (3.05 %), iso-C16:0 (9.97 %), C16:0.10m7c (1.04 %), C18:109c (3.16 %), C16:0 (9.90 %), 10-methyl C16:0 (0.59 %), iso-C17:0 (2.99 %), anteiso-C17:0 (11.16 %), C17:108c (5.90 %), C18:0 (5.66 %) and 10-methyl C18:0 (4.53 %). All of these chemical properties are consistent with the classification of the isolate in the genus Nocardiopsis.

To establish the phylogenetic position of strain IMMIB L-21T, its 16S rRNA gene sequence was determined in this study (1498 nt). Sequence database searches revealed that strain IMMIB L-21T was most closely related to species of the genus Nocardiopsis. A tree constructed using the neighbour-joining method, showing the nearest phylogenetic relatives of strain IMMIB L-21T, is shown in Fig. 1. The phylogenetic analysis confirmed the placement of strain IMMIB L-21T within the genus Nocardiopsis, with the strain forming a monophyletic clade with N. composta. However, the association of strain IMMIB L-21T with N. potens was not statistically significant (bootstrap value of 69 %). Comparative 16S rRNA gene sequence analysis demonstrated that strain IMMIB L-21T displayed sequence similarity values of less than 98.6 % to the type strains of recognized members of the genus Nocardiopsis; highest
Fig. 1. Neighbour-joining tree showing the position of strain IMMIB L-21\textsuperscript{T} in the genus \textit{Nocardiopsis}. Percentages at nodes (>)50\% represent levels of bootstrap support based on 500 resamplings. Solid circles indicate that the corresponding nodes were also recovered in maximum-likelihood and maximum-parsimony trees. \textit{Nocardiopsis alba} DSM 43377\textsuperscript{T} was used as the outgroup. Bar, 5.0\% sequence divergence.
sequence similarities were shown with *N. compta* DSM 44551T (98.6%) and *N. halophila* DSM 44494T (98.1%). However, it is clear from the DNA–DNA relatedness study that strain IMMIB L-21T represents a genomic species separate from *N. compta* DSM 44551T (DNA–DNA relatedness value 15.2 ± 6.08%; mean ± sd) and *N. halophila* DSM 44494T (6.1 ± 0.63%). These values are well below the 70.0% cut-off point recommended for the assignment of strains to the same genomic species (Wayne et al., 1987). It is also apparent that strain IMMIB L-21T can be distinguished from *N. compta* DSM 44551T and *N. halophila* DSM 44494T by a combination of phenotypic properties (Table 1).

It can be concluded from the genotypic and phenotypic data that strain IMMIB L-21T is phylogenetically distant from its neighbours and distinguishable from them on the basis of its phenotypic properties. Therefore, strain IMMIB L-21T represents a novel species of the genus *Nocardiopsis*, for which the name *Nocardiopsis potens* sp. nov. is proposed.

**Description of *Nocardiopsis potens* sp. nov.**

*Nocardiopsis potens* (po’ tens. L. part. adj. potens powerful, pertaining to the metabolic activities of the organism).

Aerobic, Gram-positive, non-acid–alcohol-fast, non-motile actinomycete. Forms a branched substrate mycelium that fragments into coconid and rod-shaped elements. Aerial hyphae differentiate into straight to flexuous chains of rod-shaped spores with smooth surfaces. Pale-yellow to brown–yellow substrate hyphae differentiate into straight to flexuous chains of rod-shaped spores. Melanoid pigment is not produced on ISP medias 6 and 7. Hydrolyses L-arabinose, 2,3-butanediol, cellobiose, citrate, xanthine. Assimilates acetate, adonitol, adipate, iso-amyl one, tyrosine and urea, but not adenine, gelatin or acetamide as simultaneous carbon and nitrogen sources. Grows in the presence of 12% NaCl. Whole-organism hydrosylates contain meso-diaminopimelic acid and no characteristic sugars. Major phospholipids are diphosphatidylglycerol, phosphatidylglycerol, phosphatidylinositol, phosphatidylglycerol mannosides and phosphatidylmethylthanolamine. Major menaquinones are MK-11(H8), MK-11(H6), MK-11(H4), MK-11(H2), MK-10(H8), MK-10(H6), MK-10(H4), MK-10(H2), MK-9(H8), MK-9(H6), MK-9(H4) and MK-9(H2). Minor amounts of MK-11, MK-8(H8), MK-8(H6) and MK-8(H2) are also present. Major fatty acids are anteiso-C15:0, anteiso-C17:0, iso-C16:0 and C16:0. Substantial amounts of iso-C14:0, iso-C15:0, C17:0ω8c, C18:1ω9c, C18:0 and tuberculostearic acid (10-methyl C18:0) are present.

The type strain is IMMIB L-21T (=DSM 45234T=CCUG 56587T), which was isolated from household waste.

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**References**


