Genome Sequence of *Enterobacter turicensis* Strain 610/05 (LMG 23731), Isolated from Fruit Powder

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We report the draft genome sequence of *Enterobacter turicensis* strain 610/05 (LMG 23731), isolated from fruit powder. The draft genome has a size of 4,182,790 bp and a G+C% content of 58.0.

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tephan et al. (1) reported the isolation from fruit powders of 12 bacterial strains, which were presumptively identified as Enterobacter sakazakii (now genus Cronobacter) based on colony appearances on Cronobacter chromogenic agars. API32E analysis revealed that these isolates were not Cronobacter and also that they did not match any existing identification profiles with high confidence. Using a polyphasic analysis scheme, Stephan et al. (1) proposed to classify two of these strains as the novel species Enterobacter turicensis. Interestingly, Cronobacter comprises a diverse genus of pathogens that cause life-threatening infantile infections, such as brain abscesses, meningitis, necrotizing enterocolitis, and septicemia (2, 3). There is, however, no indication that E. turicensis is pathogenic to humans. Not surprisingly, E. turicensis was found to share several physiological traits with the genus Cronobacter, such as production of a yellow, Pantoea-like carotenoid pigment (4) and constitutive metabolism of 5-bromo-4-chloro-3indolyl-a-D-glucopyranoside, two traits used in the differentiation of presumptive Cronobacter colonies.

Recently, Brady et al. (5) proposed that E. turicensis be recognized as a new Cronobacter species and subsequently, Masood et al. published the draft genome sequence for the type strain of E. turicensis, 508/05 (LMG 23730; DSM 18397) (6). Because the taxonomic position of these strains remains unclear, we sequenced E. turicensis strain 610/05 (LMG 23731). A library was constructed using a Nextera XT DNA sample preparation kit (Illumina, San Diego, CA), and whole-genome sequencing was performed on a MiSeq benchtop sequencer (Illumina, San Diego, CA), utilizing 500 cycles paired-end version 2 chemistry. FASTQ datasets were trimmed and assembled using default parameters in CLC Genomics Workbench, version 6.0.5 (CLC bio, Aarhus, Denmark). The draft genome of strain 610/05 is 4,182,790 bp, on 262 contigs (>500 bp in size), and has a G+C% content of 58.0. Genomic contigs were annotated using the RAST annotation server (7) to identify RNAs and protein-coding genes. The draft genome of strain 610/05 is predicted to contain 3,857 coding sequences (CDS).

The E. turicensis strain 610/05 draft genome sequence was

highly clonal with that of strain LMG 23730^T (average nucleotide identity of 99.98), as reported by Masood et al. (6). The genome possessed a number of noteworthy features, including six chaperone-usher fimbriae; curli, dulcitol, and malonate utilization; and a type III secretion system gene cluster similar in gene content to those of *Pectobacterium carotovorum* and *Pseudomonas syringae*. The genome contained two conjugative plasmids, an IncF (*tra*) plasmid that contains a copper homeostasis operon and an IncN (*virB*) plasmid similar to that found in *Salmonella enteritidis* serovar Agona strain SL483. It should be noted that the IncF plasmid was not homologous to the common virulence plasmid reported among *Cronobacter* spp., which contains a number of genus- and species-specific virulence factors (8).

Nucleotide sequence accession numbers. The whole-genome shotgun project for *E. turicensis* strain 610/05 is available in GenBank under accession number AXDM00000000. The corresponding NCBI Biosample record SAM02319257 is subject to taxonomic revision.

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REFERENCES

- Stephan R, Van Trappen S, Cleenwerck I, Vancanneyt M, De Vos P, Lehner A. 2007. Enterobacter turicensis, sp. nov. and Enterobacter helveticus sp. nov. isolated from fruit powder. Int. J. Syst. Evol. Microbiol. 57: 820–826.
- Iversen C, Mullane N, McCardell B, Tall BD, Lehner A, Fanning S, Stephan R, Joosten H. 2008. Cronobacter gen. nov., a new genus to accommodate the biogroups of Enterobacter sakazakii, and proposal of Cronobacter sakazakii gen. nov., comb. nov., Cronobacter malonaticus sp. nov., Cronobacter turicensis sp. nov., Cronobacter muytjensii sp. nov., Cronobacter dublinensis sp. nov., Cronobacter genomospecies 1, and of three subspecies, C. dublinensis subsp. dublinensis subsp. nov., Cronobacter dublinensis subsp. lausannensis subsp. nov. and Cronobacter dublinensis subsp. lactaridi subsp. nov. Int. J. Syst. Evol. Microbiol. 58:1442–1447.
- 3. Joseph S, Cetinkayaz E, Drahovska H, Levican A, Figueras MJ, Forsythe SJ. 2012. *Cronobacter condimenti* sp. nov., isolated from spiced meat and

Cronobacter unversalis sp. nov., a novel species designation for *Cronobacter* sp. genomospecies 1 recovered from a leg infection, water and food ingredients. Int. J. Syst. Evol. Microbiol. **62**:1277–1283.

- 4. Lehner A, Grimm M, Rattei T, Ruepp A, Frishman D, Manzardo GG, Stephan R. 2006. Cloning and characterization of *Enterobacter sakazakii* pigment genes and in situ spectroscopic analysis of the pigment. FEMS Microbiol. Lett. 265:244–248.
- 5. Brady C, Cleenwerck I, Venter S, Coutinho T, De Vos P. 2013. Taxonomic evaluation of the genus Enterobacter based on multilocus sequence analysis (MLSA): Proposal to reclassify E. nimipressuralis and E. amnigenus into Lelliottia gen. nov. as Lelliottia nimipressuralis comb. nov. and Lelliottia amnigena comb. nov., respectively, E. gergoviae and E. pyrinus into Pluralibacter gen. nov. as Pluralibacter gergoviae comb. nov. and Pluralibacter pyrinus comb. nov., respectively, E. cowanii, E. radicincitans, E. oryzae and E. arachidis into Kosakonia gen. nov. as Kosakonia cowanii comb. nov., Kosakonia radicincitans comb. nov., respectively, and E. turicensis, E. helveticus and E. pulveris into Cronobacter as Cronobacter pulveris comb. nov., Cronobacter helveticus comb. nov.

respectively, and emended description of the genera *Enterobacter* and *Cronobacter*. Syst. Appl. Microbiol. **36**:309–319.

- Masood N, Moore K, Farbos A, Hariri S, Paszkiewicz K, Dickins B, McNally A, Forsythe S. 2013. Draft genome sequences of three newly identified species in the genus *Cronobacter, C. helveticus* LMG23732^T, *C. pulveris* LMG24059, and *C. zurichensis* LMG23730^T. Genome Announc. 1(5):e00783-13. doi:10.1128/genomeA.00783-13.
- Aziz RK, Bartels D, Best AA, DeJongh M, Disz T, Edwards RA, Formsma K, Gerdes S, Glass EM, Kubal M, Meyer F, Olsen GJ, Olson R, Osterman AL, Overbeek RA, McNeil LK, Paarmann D, Paczian T, Parrello B, Pusch GD, Reich C, Stevens R, Vassieva O, Vonstein V, Wilke A, Zagnitko O. 2008. The RAST server: rapid annotations using subsystems technology. BMC Genomics 9:75.
- Franco AA, Hu L, Grim CJ, Gopinath G, Sathyamoorthy V, Jarvis KG, Lee C, Sadowski J, Kim J, Kothary MH, McCardell BA, Tall BD. 2011. Characterization of putative virulence genes on the related RepFIB plasmids harbored by *Cronobacter* spp. Appl. Environ. Microbiol. 77: 3255–3267.