Draft Genome Sequence of Urease-Producing *Sporosarcina pasteurii* with Potential Application in Biocement Production

Pradeep Kumar Tiwari,^{a,d} Kandarp Joshi,^{b,d} Rakhshinda Rehman,^{a,d} Vivek Bhardwaj,^{a,d} K. V. Shamsudheen,^c Sridhar Sivasubbu,^{a,d} Vinod Scaria^{c,d}

Genomics and Molecular Medicine Unit, CSIR Institute of Genomics and Integrative Biology, Mathura Road, Delhi, India^a; CSIR Open Source Drug Discovery Unit, Anusandhan Bhavan, New Delhi, India^b; GN Ramachandran Knowledge Center for Genome Informatics, CSIR Institute of Genomics and Integrative Biology, Delhi, India^c; Academy of Scientific and Innovative Research (AcSIR), Anusandhan Bhavan, New Delhi, India^d

P.K.T., K.J., R.R., and V.B. contributed equally.

We describe here the draft genome sequence of *Sporosarcina pasteurii*, a urease-producing bacterium with potential applications in biocement production.

Received 23 December 2013 Accepted 31 December 2013 Published 30 January 2014

Citation Tiwari PK, Joshi K, Rehman R, Bhardwaj V, Shamsudheen KV, Sivasubbu S, Scaria V. 2014. Draft genome sequence of urease-producing *Sporosarcina pasteurii* with potential application in biocement production. *Genome Announc.* 2(1):e01256-13. doi:10.1128/genomeA.01256-13.

Copyright © 2014 Tiwari et al. This is an open-access article distributed under the terms of the [Creative Commons Attribution 3.0 Unported license](https://creativecommons.org/licenses/by/3.0/).

Address correspondence to Sridhar Sivasubbu, s.sivasubbu@igib.res.in, or Vinod Scaria, vinods@igib.res.in.

The use of microbes in biomineralization has been an active area in research worldwide (1, 2). One of the major microorganisms studied for its biomineralization capacity has been the urease-producing species *Sporosarcina pasteurii*, which has the potential to precipitate calcium carbonate and thus aid in the production of biocement (3, 4). The organism produces a significantly high amount of urease without the requirement for additional methods of concentration (3, 4). *S. pasteurii* releases carbonate ions, which in a calcium-rich environment and under adequate conditions can precipitate hard calcium carbonate or calcite (5). A recent crystallographic study on the citrate-bound urease enzyme complex shed light on the mechanisms of action of this enzyme (6). The organism has an additional advantage in that it tolerates a highly alkaline environment, which is required for biomineralization (7). The microorganism has also gained interest and applications in a wide variety of areas, including the restoration of structures and mining (8), and it may have biomedical applications. The microorganism also provides an ecofriendly alternative to traditional cement production systems.

The strain was procured from the National Collection of Industrial Microorganisms (NCIM) maintained at the CSIR National Chemical Laboratory, Pune, India (NCIM ID, 2477). DNA was isolated from the culture, which was revived from the freeze-dried samples. The raw sequence data were generated after library preparation on an Illumina HiSeq 2500 platform as per the manufacturer's protocols. A total of >11.5 million single-end reads of 101 bases were generated. The draft genome was assembled *de novo* using the CLC Genomics Workbench 6.0.5. The assembly resulted in 38 contigs with an N₅₀ value of 232,940 bp and a total assembly of 4,040,808 bp. Further, automated gene prediction on the draft genomes was performed using RAST server (9). The analysis revealed 4,259 genes, including 46 RNA genes.

Nucleotide sequence accession numbers. This whole-genome shotgun project has been deposited at DDBJ/EMBL/GenBank under the accession no. [AYOX000000000](https://www.ncbi.nlm.nih.gov/nuccore/AYOX000000000). The version described in this paper is version AYOX000000000.1.

ACKNOWLEDGMENTS

We acknowledge Anupam Kumar Mondal for his technical help and Mitali Mukerji for her discussions. We acknowledge the National Collection of Industrial Microorganisms (NCIM), CSIR National Chemical Laboratory, Pune, India, for the resource material.

The sequencing was performed as part of the Undergraduate exploratory Sequencing Project (USP) as part of the coursework of AcSIR at CSIR-IGIB. This work was funded by the Council of Scientific and Industrial Research (CSIR), India. P.K.T. and K.J. acknowledge fellowships from DBT-BINC-JRF and V.B. acknowledges a fellowship from CSIR-NET-JRF.

REFERENCES

1. Sarikaya M. 1999. Biomimetics: materials fabrication through biology. *Proc. Natl. Acad. Sci. U. S. A.* 96:14183–14185. [http://dx.doi.org/10.1073/pnas.96.25.14183](https://doi.org/10.1073/pnas.96.25.14183).
2. Cantaert B, Beniash E, Meldrum FC. 2013. Nanoscale confinement controls the crystallization of calcium phosphate: relevance to bone formation. *Chemistry* 19:14918–14924. [http://dx.doi.org/10.1002/chem.201302835](https://doi.org/10.1002/chem.201302835).
3. Lauchnor EG, Schultz LN, Bugni S, Mitchell AC, Cunningham AB, Gerlach R. 2013. Bacterially induced calcium carbonate precipitation and strontium coprecipitation in a porous media flow system. *Environ. Sci. Technol.* 47:1557–1564. [http://dx.doi.org/10.1021/es304240y](https://doi.org/10.1021/es304240y).
4. Rodriguez DE, Thula-Mata T, Toro EJ, Yeh YW, Holt C, Holliday LS, Gower LB. 2014. Multifunctional role of osteopontin in directing intrafibrillar mineralization of collagen and activation of osteoclasts. *Acta Biomater.* 10:494–507. [http://dx.doi.org/10.1016/j.actbio.2013.10.010](https://doi.org/10.1016/j.actbio.2013.10.010).
5. Bang SS, Galinat JK, Ramakrishnan V. 2001. Calcite precipitation induced by polyurethane-immobilized *Bacillus pasteurii*. *Enzyme Microb. Technol.* 28:404–409. [http://dx.doi.org/10.1016/S0141-0229\(00\)00348-3](https://doi.org/10.1016/S0141-0229(00)00348-3).
6. Benini S, Kosikowska P, Cianci M, Mazzei L, Vara A, Berlicki L, Ciarli S. 2013. The crystal structure of *Sporosarcina pasteurii* urease in a complex with citrate provides new hints for inhibitor design. *J. Biol. Inorg. Chem.* 18:391–399. [http://dx.doi.org/10.1007/s00775-013-0983-7](https://doi.org/10.1007/s00775-013-0983-7).

7. Wiley WR, Stokes JL. 1962. Requirement of an alkaline pH and ammonia for substrate oxidation by *Bacillus pasteurii*. J. Bacteriol. 84:730–734.
8. Raut SH, Sarode DD, Lele SS. 2014. Biocalcification using *B. pasteurii* for strengthening brick masonry civil engineering structures. World J. Microbiol. Biotechnol. 30:191–200. doi: <http://dx.doi.org/10.1007/s11274-013-1439-5>.
9. 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. <http://dx.doi.org/10.1186/1471-2164-9-75>.