



HAL
open science

Draft Genome Sequence of *Carnobacterium divergens* V41, a Bacteriocin-Producing Strain

Benoit Remenant, Frederic Borges, Catherine Cailliez-Grimal, Anne-Marie Revol-Junelles, Laurent Marché, Aurélie Lajus, Claudine Médigue, Marie-France M.-F. Pilet, Hervé Prévost, Monique Zagorec

► **To cite this version:**

Benoit Remenant, Frederic Borges, Catherine Cailliez-Grimal, Anne-Marie Revol-Junelles, Laurent Marché, et al.. Draft Genome Sequence of *Carnobacterium divergens* V41, a Bacteriocin-Producing Strain. *Genome Announcements*, 2016, 4 (5), pp.e01109-16. 10.1128/genomeA.01109-16. hal-02498294

HAL Id: hal-02498294

<https://hal.univ-lorraine.fr/hal-02498294>

Submitted on 27 May 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Draft Genome Sequence of *Carnobacterium divergens* V41, a Bacteriocin-Producing Strain

Benoît Remenant,^{a*} Frédéric Borges,^b Catherine Cailliez-Grimal,^b Anne-Marie Revol-Junelles,^b Laurent Marché,^a Aurélie Lajus,^c Claudine Médigue,^d Marie-France Pilet,^a Hervé Prévost,^a Monique Zagorec^a

UMR1014 SECALIM, INRA, Oniris, Nantes, France^a; Université de Lorraine, Laboratoire d'Ingénierie des Biomolécules (LIBio), Vandoeuvre-lès-Nancy, France^b; Laboratoire d'Analyse Bioinformatique en Génomique et Métabolisme, CNRS-UMR 8030, Évry, France^c; Commissariat à l'énergie atomique (CEA), Direction de la Recherche Fondamentale (DRF), Institut de Génomique, Genoscope, Évry, France^d

* Present address: Benoît Remenant, Laboratoire de la Santé des Végétaux, Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail, Angers, France.

In this study, we present the draft genome sequence of *Carnobacterium divergens* V41. This strain was previously reported as producing divercin V41, a bacteriocin of interest for food biopreservation. Its genome revealed also the presence of a gene cluster putatively involved in polyketide production, which is unique in lactic acid bacteria.

Received 16 August 2016 Accepted 18 August 2016 Published 13 October 2016

Citation Remenant B, Borges F, Cailliez-Grimal C, Revol-Junelles A-M, Marché L, Lajus A, Médigue C, Pilet M-F, Prévost H, Zagorec M. 2016. Draft genome sequence of *Carnobacterium divergens* V41, a bacteriocin-producing strain. *Genome Announc* 4(5):e01109-16. doi:10.1128/genomeA.01109-16.

Copyright © 2016 Remenant et al. This is an open-access article distributed under the terms of the [Creative Commons Attribution 4.0 International license](https://creativecommons.org/licenses/by/4.0/).

Address correspondence to Monique Zagorec, monique.zagorec@oniris-nantes.fr.

Carnobacterium spp. are lactic acid bacteria (LAB) whose taxonomic classification has been modified several times. The *Carnobacterium* genus is currently composed of 11 species that have been isolated mostly from water or sediment and/or cold environments. Among these, *Carnobacterium maltaromaticum* and *Carnobacterium divergens* are also dominant in meat (beef, pork, and poultry), seafood (fish and shrimps), and dairy (raw milk and cheese) food products. These two species can act as food spoilage bacteria or as protective cultures, depending on the strain and on the food product (1, 2). *C. divergens* V41 (CNCM I4028), isolated from fish viscera, produces divercin V41, a class IIa bacteriocin inhibiting *Listeria monocytogenes* (3, 4).

The *C. divergens* V41 genome was sequenced using Illumina HiSeq 2000 technology with the sequencing kit TruSeq SBS version 5 (Illumina, CA). A total of 25,762,368 (50-bp) paired reads were assembled *de novo* with the Velvet software (5) into 32 contigs, ranging from 208 to 775,204 bp, with an N_{50} estimated at 386,603 bp. The assembled sequence was 2,743,912 bp, with a G+C content of 35.38%. This genome size is similar to that of other *Carnobacterium* species but smaller than those of *C. maltaromaticum* LMA28 (3.65 Mbp) (6) and ATCC 35586 (3.54 Mbp) (7), although the two species are close (1).

Annotation performed on the MicroScope platform (8) detected 2,589 coding sequences (CDSs) and 38 tRNAs. Upstream from the *dnvVTIRK* gene cluster, which was previously reported as being responsible for divercin V41 production (4), we noticed a CDS similar to PedC, a thiol-disulfide oxidoreductase putatively involved in the posttranslational maturation of bacteriocins (9). No other bacteriocin production genes were identified.

More interestingly, we noticed a 39-kb genomic island not yet reported in LAB, surrounded by transposases suggesting its acquisition through horizontal gene transfer. It encompasses 9 CDSs identified as polyketide synthases/nonribosomal peptide synthases (PKS/NRPS) or PKS/NRPS-like enzymes, a putative regu-

lator of the TetR family, and 3 CDSs encoding putative transporters. This *C. divergens* V41 PKS/NRPS genomic island was similar to that of *Streptococcus mutans* UA59, a pathogen responsible for dental caries (10, 11). Identity scores were 30 to 50% and 57 to 80% with *S. mutans* NRPS/PKS enzymes and transporters, respectively. The molecules produced by such nonribosomal synthesis may have various functions, including antimicrobial or immunomodulatory activities, oxidative stress resistance, or cytotoxicity (12). Some have been reported as pigments without a description of their physiological role. The antiSMASH (antibiotics & Secondary Metabolite Analysis Shell) (13) monomer predicted structure was (pk) + (Mal) + (Leu-Ser) + (Pro-Val-Cys-Gly) + (pk). However, no putative function could be deduced from this predicted structure. Although the production of this unexpected secondary metabolite has not been evidenced, it merits attention especially for the use of *C. divergens* strain V41 in food bioprotection. PCR experiments confirmed that this gene cluster was unique in *C. divergens* V41 among 25 other *C. divergens* strains isolated from different food products.

Accession number(s). This whole-genome shotgun project has been deposited in ENA under the accession numbers [FLU01000001](https://ena.ebi.ac.uk/ena/record/FLU01000001) to [FLU01000032](https://ena.ebi.ac.uk/ena/record/FLU01000032). The versions described in this paper are the first versions.

ACKNOWLEDGMENTS

This work was supported by UMR1014 Secalim and by the Pays de la Loire region. The LABGeM (CEA/IG/Genoscope & CNRS UMR8030) and the France Génomique National infrastructure (funded as part of the Investissement d'avenir program managed by Agence Nationale pour la Recherche, contract ANR-10-INBS-09) are acknowledged for support within the MicroScope annotation platform.

We also thank Gilles Kergourlay for genomic DNA purification and Tristan Gérard for helpful assistance with PKS-NRPS operon characterization.

REFERENCES

1. Laursen BG, Bay L, Cleenwerck I, Vancanneyt M, Swings J, Dalgaard P, Leisner JJ. 2005. *Carnobacterium divergens* and *Carnobacterium maltaromaticum* as spoilers or protective cultures in meat and seafood: phenotypic and genotypic characterization. *Syst Appl Microbiol* 28:151–164. <http://dx.doi.org/10.1016/j.syam.2004.12.001>.
2. Pilet MF, Laursen BG, Prévost H, Drider D, Dalgaard P. 2007. *Carnobacterium*: positive and negative effects in the environment and in foods. *FEMS Microbiol Rev* 31:592–613. <http://dx.doi.org/10.1111/j.1574-6976.2007.00080.x>.
3. Pilet MF, Dousset X, Barre R, Novel G, Desmazeaud M, Piard JC. 1995. Evidence for two bacteriocins produced by *Carnobacterium piscicola* and *Carnobacterium divergens* isolated from fish and active against *Listeria monocytogenes*. *J Food Protect* 58:256–262.
4. Métivier A, Pilet MF, Dousset X, Sorokine O, Anglade P, Zagorec M, Piard JC, Marion D, Cenatiempo Y, Frémaux C. 1998. Divercin V41, a new bacteriocin with two disulphide bonds produced by *Carnobacterium divergens* V41: primary structure and genomic organization. *Microbiol-ogy* 144:2837–2844. <http://dx.doi.org/10.1099/00221287-144-10-2837>.
5. Zerbino DR, Birney E. 2008. Velvet: algorithms for *de novo* short read assembly using de Bruijn graphs. *Genome Res* 18:821–829. <http://dx.doi.org/10.1101/gr.074492.107>.
6. Cailliez-Grimal C, Chaillou S, Anba-Mondoloni J, Loux V, Afzal MI, Rahman A, Kergourlay G, Champomier-Vergès MC, Zagorec M, Dalgaard P, Leisner JJ, Prévost H, Revol-Junelles AM, Borges F. 2013. Complete chromosome sequence of *Carnobacterium maltaromaticum* LMA 28. *Genome Announc* 1(1):e00115-12. <http://dx.doi.org/10.1128/genomeA.00115-12>.
7. Leisner JJ, Hansen MA, Larsen MH, Hansen L, Ingmer H, Sørensen SJ. 2012. The genome sequence of the lactic acid bacterium, *Carnobacterium maltaromaticum* ATCC 35586 encodes potential virulence factors. *Int J Food Microbiol* 152:107–115. <http://dx.doi.org/10.1016/j.ijfoodmicro.2011.05.012>.
8. Vallenet D, Belda E, Calteau A, Cruveiller S, Engelen S, Lajus A, Le Fèvre F, Longin C, Mornico D, Roche D, Rouy Z, Salvignol G, Scarpelli C, Thil Smith AA, Weiman M, Médigue C. 2013. MicroScope—an integrated microbial resource for the curation and comparative analysis of genomic and metabolic data. *Nucleic Acids Res* 41:D636–D647. <http://dx.doi.org/10.1093/nar/gks1194>.
9. Back A, Borges F, Mangavel C, Paris C, Rondags E, Kapel R, Aymes A, Rogniaux H, Pavlović M, van Heel AJ, Kuipers OP, Revol-Junelles AM, Cailliez-Grimal C. 2016. Recombinant pediocin in *Lactococcus lactis*: increased production by propeptide fusion and improved potency by co-production with PedC. *Microb Biotechnol* 9:466–477. <http://dx.doi.org/10.1111/1751-7915.12285>.
10. Joyner PM, Liu J, Zhang Z, Merritt J, Qi F, Cichewicz RH. 2010. Mutanobactin A from the human oral pathogen *Streptococcus mutans* is a cross-kingdom regulator of the yeast-mycelium transition. *Org Biomol Chem* 8:5486–5489. <http://dx.doi.org/10.1039/c0ob00579g>.
11. Wu C, Cichewicz R, Li Y, Liu J, Roe B, Ferretti J, Merritt J, Qi F. 2010. Genomic island TnSmu2 of *Streptococcus mutans* harbors a nonribosomal peptide synthetase-polyketide synthase gene cluster responsible for the biosynthesis of pigments involved in oxygen and H₂O₂ tolerance. *Appl Environ Microbiol* 76:5815–5826. <http://dx.doi.org/10.1128/AEM.03079-09>.
12. Donia MS, Fischbach MA. 2015. Small molecules from the human microbiota. *Science* 349:1254766. <http://dx.doi.org/10.1126/science.1254766>.
13. Weber T, Blin K, Duddela S, Krug D, Kim HU, Brucoleri R, Lee SY, Fischbach MA, Müller R, Wohlleben W, Breitling R, Takano E, Medema MH. 2015. antiSMASH 3.0—a comprehensive resource for the genome mining of biosynthetic gene clusters. *Nucleic Acids Res* 43:W237–W243. <http://dx.doi.org/10.1093/nar/gkv437>.