Relation between the lack of the D-lactate dehydrogenase gene and the metabolism of D-lactate by *Propionibacterium freudenreichii*

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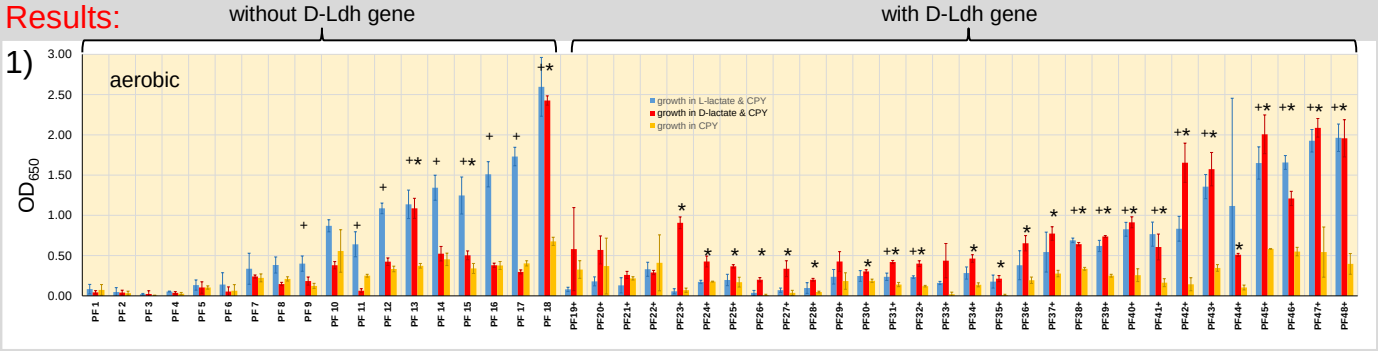
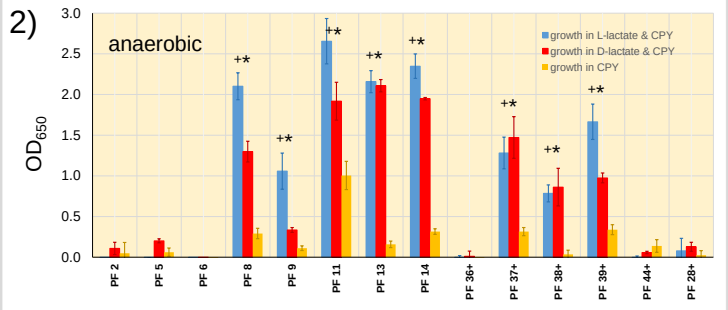
Introduction: In Swiss-type cheese, *Propionibacterium freudenreichii* produces the sweetish, nutty flavor and typical eyes by mainly catabolizing lactate to propionate, acetate and CO_2. In the presence of both lactate isomers, *P. freudenreichii* metabolizes preferably L-lactate. According to Crow (1986) the D-lactate dehydrogenase (D-Ldh) is inhibited more by high intracellular pyruvate concentration than the L-Ldh[1]. Using the reference genome[2] of the *P. freudenreichii* strain CIRM-BIA1, 48 *P. freudenreichii* (PF) strains from Agroscope strain collection were checked for the presence of orthologues of the L-Ldh and D-Ldh genes. All of the tested strains harbor two L-Ldh genes (EC 1.1.1.27) but only 30 strains carry the D-Ldh gene (EC 1.1.1.28). Strains without D-Ldh gene are considered to be interesting for cheese ripening. We hypothesize they metabolize less lactate, grow less and therefore, ripening quality of long-ripened Swiss-type cheeses could be improved.

Study: The relation between Ldh genes (especially the presence/absence of D-Ldh) and lactate catabolism was examined measuring aerobic 1) and anaerobic 2) growth (OD_{650}) in three different broths: casein-peptone & yeast (CPY), L-lactate & CPY and D-lactate & CYP (72h at 30°C). Lactate degradation in experimental Emmental (ET) cheeses 3) produced with 14 PF strains was monitored in the warm room period from week 5 (5W) to week 8 (8W).

Results:

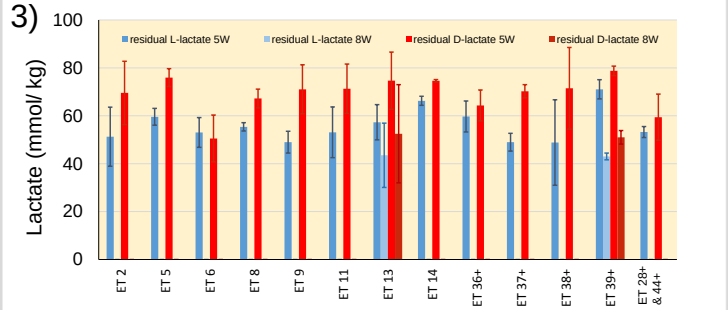


1) Compared to CPY, most of the strains harbouring the D-Ldh gene, showed significant growth in D-lactate as well as three strains without the D-Ldh gene [significant growth at $p < 0.05$: in D-lactate (*), in L-lactate (+)].



2) 14 out of the 48 tested strains were studied under anaerobic conditions. Compared to CPY, significant growth was observed in D- and L-lactate independently of the presence of the D-Ldh gene.

3) In most of the ET cheeses produced with the same 14 PF strains, both lactate isomers were completely metabolized during the warm room period, confirming the results of the anaerobic growth test.



Conclusions:
The ability of *P. freudenreichii* to grow in D-lactate broth and to catabolise D-lactate under anaerobic conditions seems not to depend on the presence of the D-Ldh gene found in the 30 *P. freudenreichii* strains.
Further studies are needed about the metabolism of both lactate isomers in *P. freudenreichii*.

[1] Crow, V. L. 1986, Appl. Environ. Microbiol. 52, 352-358
[2] Falentin et al. 2010, PLoS ONE. 5 (7): e11748