Journal of Biological Chemistry 2014 vol.289 N5, pages 2960-2971

Cardiolipin is dispensable for oxidative phosphorylation and non-fermentative growth of alkaliphilic Bacillus pseudofirmus OF4

Liu J., Ryabichko S., Bogdanov M., Fackelmayer O., Dowhan W., Krulwich T.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Cardiolipin (CL), a membrane phospholipid in bacteria and mitochondria, has been hypothesized to facilitate movement of protons on the outer surface of membranes in support of respiration-dependent ATP synthesis, oxidative phosphorylation (OXPHOS). If so, the high levels of membrane CL found in alkaliphilic bacteria, such as Bacilluspseudofirmus OF4, might facilitate its robust OXPHOS at pH 10.5, where the bulk protonmotive (PMF) force is low. To address the role of CL in Bacillus pseudofirmus OF4, we studied strains in which genes (cls) potentially encoding a CL synthase (CLs) were deleted: three single (AclsA, AclsB, and AclsC), one double (AclsA/B), and one triple (AclsA/B/C) mutant. Two-dimensional thin layer chromatography analyses of lipid extracts from 32P-labeled strains showed that the wild-type CL content was 15% of total phospholipids at pH 10.5 versus 3% at pH 7.5 during log phase. The % CL was higher (28-33%) at both pH values during stationary phase. The clsA gene plays a major role in CL biosynthesis as no detectable CL was found in AclsA-containing mutants, whereas the CL precursor phosphatidylglycerol was elevated. The AclsB mutant exhibited no significant reduction in CL, but clsB expression was up-regulated and appeared to support growth at pH 7.5. In the absence of detectable CL, the alkaliphile showed no significant deficits in non-fermentative growth, respiration-dependent ATP synthesis, or salt tolerance. Minor deficits in respiration and ATP synthase assembly were noted in individual mutants. In long term survival experiments, significant growth defects were found in AclsA strains and the AclsC strain at pH 10.5.

http://dx.doi.org/10.1074/jbc.M113.536193