

pXO1-and pXO2-like Plasmids in *Bacillus cereus* and *B. thuringiensis*

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Dear Editor

The *Bacillus cereus* group of organisms contains *B. thuringiensis*, *B. anthracis* and *B. cereus* (sensu stricto). This group of Gram-positive sporeformers forms a highly homogeneous subdivision of the genus *Bacillus*. Demonstration of the high genetic relatedness suggests that *B. anthracis*, *B. cereus* and *B. thuringiensis* are members of a single species, *B. cereus sensulato*. By definition, *B. cereus* is acrySTALLIFEROUS, but a *B. cereus* strain carrying a functional cry gene is considered as a *B. thuringiensis* strain. *B. anthracis* is the etiological agent of anthrax, an acute fatal disease found primarily among herbivores, but in fact, all mammals are susceptible. In recent years, it has become best known for its use as a biological weapon (1-3).

In *B. anthracis*, *B. thuringiensis*, and the emetic *B. cereus*, major virulence factors are located extrachromosomally on large plasmids (2). Fully virulent strains of *B. anthracis* carry two large plasmids, pXO1 (181 kb) and pXO2 (96 kb), which encode the machinery necessary to produce and regulate the anthrax virulence factors, the tripartite toxin and the capsule, respectively (1). *B. anthracis* plasmids can easily be transferred for typing purposes. For example, it is believed that a plasmidless isolates of *B. anthracis* is indistinguishable from *B. cereus*. Numerous studies have attempted to characterize the role of these plasmids in virulence. Generating a plasmid-free strain is important to elucidate the crosstalk between the plasmids and host chromosome (3, 4).

Although pXO1 and pXO2 are considered to be specific to *B. anthracis*, there are some reports of rare *B. cereus* strains harboring plasmids with similarity to these plasmids (4). In Iran, pXO1 plasmid has been transferred from *B. anthracis* to *B. cereus* (5, 6). A single 208-kb plasmid, named pBc10987, was identified from the non-pathogenic isolate.

B. cereus ATCC 10987.pBc10987 shows surprising similarity to the plasmid pXO1 of *B. anthracis* (40% nucleotide identity), however, it lacks the pathogenicity island (PI) containing the genes that encode for the tripartite lethal toxin and its associated regulators. A 191-kb plasmid with a high degree of similarity and synteny to *B. anthracis* pXO1 was found in *B. cereus* G9241. In addition, *B. cereus* G9241 contains a second 218-kb plasmid, previously unidentified, that encodes a novel polysaccharide capsule biosynthetic cluster. These plasmids are expected to contribute greatly to the observed anthrax-like clinical presentation. The pXO1-like plasmid, named pBCXO1, is 99.6% identical to pXO1 (7, 8).

In a study, the plasmids from *B. cereus* isolates that produce emetic toxin or are linked to periodontal disease were sequenced and analyzed. Two periodontal isolates examined contained almost 272-kb plasmids, named pPER272. The emetic toxin-producing isolate contained one 270-kb plasmid, named pCER270, encoding the cereulide biosynthesis gene cluster. Comparative sequence analyses of these *B. cereus* plasmids revealed a high degree of sequence similarity to the *B. anthracis* pXO1 plasmid, especially in a putative replication region (4).

Recent studies have reported the presence of pXO1-like plasmids in clinical isolates of *B. cereus*, as well as the presence of pXO2-like plasmids in both a clinical strain and a commercial biopesticide strain of *B. thuringiensis*. *B. cereus*D-17, *B. cereus* 43881, and *B. thuringiensis* 33679 have sequences that are similar to more than one-half of the pXO1 sequences. *B. thuringiensis subsp. israelensis* carries pBtoxis, and its toxin crystals have been demonstrated to be one of the most toxic combinations tested (9, 10). In addition to the toxin genes, pBtoxis encodes a number of genes that are thought to enhance crystal formation and subsequent cell viability by acting as chaperones.

Implication for health policy/practice/research/medical education:

In this brief article, the author summarizes and presents pXO1- and pXO2-like plasmids. These plasmids can be used in producing vaccines against anthrax.

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Interestingly, like pBC10987 and pXO1, pBtoxis encodes peptides that are involved in host sporulation and germination (3).

In another study, pAW63 plasmid from the entomopathogenic *B. thuringiensis* sv. *kurstaki* was chosen as Gram-positive model plasmid which had homology with several other Gram-positive plasmids most notably with pXO2, the second virulence plasmid of *B. anthracis*, and pBT9727 was chosen from the pathogenic strain *B. thuringiensis* sv. *konkukian* 97-27 (10).

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