



A simple method for the separation of *Bacillus thuringiensis* spores and crystals

Jihane Rahbani, Dominique Salameh, Mireille Kallassy Awad, Laure Chamy,
Cédric Brandam, Roger Lteif

► To cite this version:

Jihane Rahbani, Dominique Salameh, Mireille Kallassy Awad, Laure Chamy, Cédric Brandam, et al.. A simple method for the separation of *Bacillus thuringiensis* spores and crystals. *Journal of Microbiological Methods*, 2014, 107, pp.147-149. 10.1016/j.mimet.2014.10.003 . hal-01919681

HAL Id: hal-01919681

<https://hal.science/hal-01919681>

Submitted on 12 Nov 2018

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.



Open Archive Toulouse Archive Ouverte (OATAO)

OATAO is an open access repository that collects the work of Toulouse researchers and makes it freely available over the web where possible

This is an author's version published in: <http://oatao.univ-toulouse.fr/20239>

Official URL: <https://doi.org/10.1016/j.mimet.2014.10.003>

To cite this version:

Rahbani, Jihane  and Salameh, Dominique and Awad, Mireille kallassy and Chamy, Laure and Brandam, Cédric  and Lteif, Roger *A simple method for the separation of Bacillus thuringiensis spores and crystals.* (2014) Journal of Microbiological Methods, 107. 147-149. ISSN 0167-7012

Any correspondence concerning this service should be sent
to the repository administrator: tech-oatao@listes-diff.inp-toulouse.fr

A simple method for the separation of *Bacillus thuringiensis* spores and crystals

Jihane Rahbani Mounsef^{a,b,c,*}, Dominique Salameh^c, Mireille kallassy Awad^c, Laure Chamy^c, Cedric Brandam^{a,b}, Roger Lteif^c

^a Université de Toulouse, INPT, UPS, Laboratoire de Génie Chimique, 4, Allée Emile Monso, F-31030 Toulouse, France

^b CNRS, Laboratoire de Génie Chimique, F-31030 Toulouse, France

^c Université Saint Joseph de Beyrouth, B.P. 11-514 Riad El Solh, Beyrouth 1107 2050, Liban

ARTICLE INFO

Keywords:

Bacillus thuringiensis

Crystals

Hexane

Purification

Spores

ABSTRACT

A simple new method, for separating *Bacillus thuringiensis* crystals from spores and cell debris, is described. The developed purification method uses hexane and low speed centrifugation and does not require any expensive material or reagents.

Bacillus thuringiensis (Bt) is a Gram-positive spore forming bacterium that is able to produce parasporal crystals made of proteins (Cry) during sporulation. The parasporal crystals of studied subspecies showed a wide range of toxicity against different insect orders (Diptera, Lepidoptera and Coleoptera) and other invertebrates (Feitelson, 1993; Schnepf et al., 1998). Assays of Cry proteins and the studying of the crystal biochemistry require pure crystals as standards. Moreover, assays of expression of the Cry transferred genes in Bt transgenic plants are based on a specific antibody reaction and they require pure biologically active crystals as antigens. A variety of techniques have been developed for the extraction of *B. thuringiensis* crystals. However, proper separation of crystals from bacterial spores' remains hampered by the proximity of their respective buoyant densities 1.25 and 1.30 g·cm⁻³, and by the tendency of spores to clump and entrap crystals. Reported techniques of Bt crystal purification include isopycnic centrifugation in caesium chloride (CsCl) (Fast, 1972), gradient centrifugation in Sodium bromide (NaBr) (Ang and Nickerson, 1978), density gradient centrifugation in Renografin (Sharpe et al., 1975), and centrifugation through step gradients of Ludox (Zhu et al., 1989). The most commonly adopted

strategy is that described by Thomas and Ellar (1983) in which Bt spores and crystals are separated using discontinuous sucrose density gradients (67 to 72 to 79% [wt/vol] sucrose) with ultracentrifugation (Ito et al., 2004; Rolle, 2013). Foam flotation based extraction strategies (Sharpe et al., 1978) and methods using carboxymethyl cellulose column chromatography (Murty et al., 1994) have also been described. All the above-mentioned methods are partially successful and are time demanding or they require expensive equipment and reagents. Crystals of different strains differ by their shape, size and surface antigens whereas Bt spores are commonly hydrophobic (Doyle et al., 1984). We have taken the advantage of the latter characteristic to develop a simple and rapid method for preparation of highly pure crystals from crystal-spore mixtures of Bt. Protein crystals were purified from two subspecies of *B. thuringiensis* registered as H₃^{MKA} and Lip^{MKA}, designated by "H₃" and "Lip", isolated from the Lebanese soil (El Khoury et al., 2014). Bacterial cultures were made in 3 L of Anderson medium (Anderson, 1990) at 30 °C in a 5 L bioreactor with a volumetric gas transfer coefficient (k_{La}) of 13.32 h⁻¹. Cells were grown for about 48 h or until approximately complete autolysis had occurred releasing the spores and the toxin crystals in the culture medium. The developed purification procedure was first used in an attempt to isolate the spherical crystals of H₃. The liquid culture medium was centrifuged at 6000 rpm, 4 °C for 10 min and the obtained pellet was washed twice by suspending in 1 M NaCl containing 0.01% triton X-100. The pellet was then suspended in a 50 mL centrifuge tube with a saline solution, in order to enhance the hydrophobic interactions. An organic solvent

* Corresponding author at: Université de Toulouse, INPT, UPS, Laboratoire de Génie Chimique, 4, Allée Emile Monso, F-31030 Toulouse, France. Tel.: +33 00961 70 265 746.

E-mail addresses: gihane.rahbany@usj.edu.lb (J.R. Mounsef),

dominique.salameh@usj.edu.lb (D. Salameh), mireille.kallassy@usj.edu.lb (M. Awad),

laure.chamy@usj.edu.lb (L. Chamy), cedric.brandam@ensiacet.fr (C. Brandam),

roger.lteif@usj.edu.lb (R. Lteif).

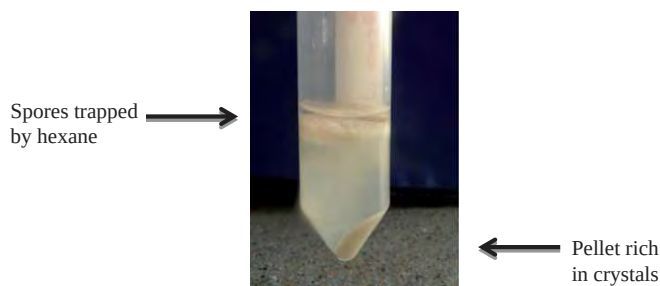


Fig. 1. Separation of spores, crystals and cell debris upon centrifugation (intended for color reproduction on the Web and in print).

(diethyl ether, dichloromethane or hexane) was added to a ratio less or equal to 10% (50, 75, or 100 $\mu\text{L}/\text{mL}$ of aqueous suspension) to minimize the risk of altering crystals. The suspension was sonicated at 100 W for 10 min to dispel clumping then centrifuged at 6000 rpm for 10 min. The obtained pellet was resuspended in a saline solution, the organic solvent was added again and the same procedure was repeated three to four times. Finally the pellet was washed twice with cold distilled water. Among the hydrophobic organic solvents tested (diethylether, dichloromethane and hexane), only the hexane could trap the spores under the conditions described. The compositions of the different phases of the centrifuged solution were verified by observation at 100 $\times$ using a light microscope after staining with Coomassie blue solution (0.13% (w/v) Coomassie blue reagent; 50% (v/v) acetic acid). Spores were trapped by the hexane on the top layer; cell debris remained in the aqueous phase while the crystals accumulated to form the pellet (Fig. 1).

The highest crystal purity was attained when the hexane was added at a concentration of 10% which is the closest to the ratio found by Doyle et al. (1984) (approximately 133 μL hydrocarbon/mL cell suspension) for maximal adherence of spores to hydrocarbons. The purified crystals were air dried (away from light) and weighed. About 10 mg of 99% pure crystals was obtained from 35 mL of culture. After alkaline dissolution of the toxin proteins obtained in the culture medium (Rivera, 1998), the toxin protein concentration was estimated by the Bradford method, using the bovine serum albumin as a standard (Bradford, 1976). The crystal's recovery yield was calculated according to the following equation:

$$\text{Recovery yield} = \frac{\text{Crystals dry weight} \times 100}{\text{Mass of toxin proteins in the culture}}$$

The recovery yield of H_3 crystals was 44%. Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (Fig. 2) indicated that the proteins

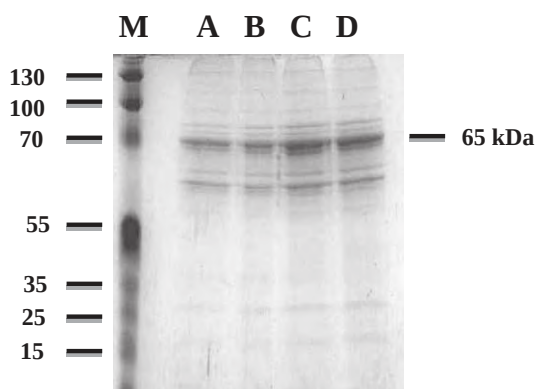


Fig. 2. Stained sodium dodecyl sulfate 10% polyacrylamide gel after electrophoresis of H_3 crystals before (lanes A, B) and after purification (lanes C, D), lane M, molecular weight standards.

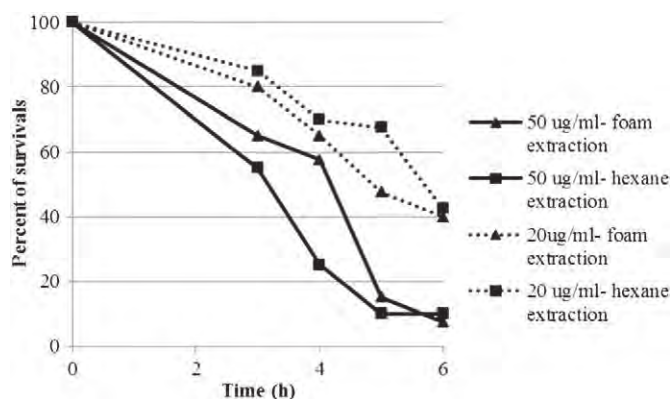


Fig. 3. Survival of *Anopheles gambiae* four instar larvae infected with H_3 purified toxins. This result is representative of two independent experiments. Same results have been obtained on third instar Larvae.

composing the crystals of H_3 were unaffected and that proteolysis did not occur during the purification.

The toxicity of the purified H_3 crystals was compared to that of traditionally extracted crystals using the foam separation technique (Sharpe et al., 1978). As shown in Fig. 3 the new extraction protocol does not affect the efficiency of crystal toxicity against *Anopheles gambiae* larvae.

The purification method was also used to separate the crystals of another *B. thuringiensis* strain "Lip" which produces bipyramidal crystals and few cuboidal crystals. About 67 mg of 99% pure crystals was obtained from 35 mL of culture medium which corresponds to a recovery yield of 92%. The toxin protein concentration determined in "Lip" culture medium was 3-fold greater than that obtained in H_3 culture medium. Lip crystals are bigger and have higher content of proteins than H_3 crystals which could explain the higher recovery yield of these crystals.

The purification procedure described herein was shown efficient at separating spores and crystals of two different *B. thuringiensis* strains having different crystals shapes. It is an easy and fast separation method that does not require ultracentrifugation or any expensive material. Moreover larger quantities of purified crystals could be prepared using this method than are conveniently available from density gradient centrifugation.

We would like to thank the research council of Saint Joseph University and Arcenciel for financing and supporting this work.

References

- Anderson, T., 1990. Effects of Carbon:Nitrogen Ratio and Oxygen on the Growth Kinetics of *Bacillus thuringiensis* and Yield of Bioinsecticidal Crystal Protein (M.Sc Thesis) The University of Western Ontario, London, Canada.
- Ang, Barbara J., Nickerson, Kenneth W., 1978. Purification of the protein crystal from *Bacillus thuringiensis* by zonal gradient centrifugation. Appl. Environ. Microbiol. 36 (4), 625–626.
- Bradford, M.M., 1976. A rapid and sensitive method for the quantitation of microgram quantities of protein utilizing the principle of protein-dye binding. Anal. Biochem. 72, 248–254.
- Doyle, Ronald J., Fariborz, Nedjat-Haiem, Singh, Jyoti S., 1984. Hydrophobic characteristics of bacillus spores. Curr. Microbiol. 10, 329–332.
- El Khoury, M., Azzouz, H., Chavanieu, A., Abdelmalak, N., Chopineau, J., Awad, k.M., 2014. Isolation and characterization of a new *Bacillus thuringiensis* strain Lip harboring a new cry 1 Aa gene highly toxic to *Ephesia kuehniella* (Lepidoptera: Pyralidae) larvae. Arch. Microbiol. <http://dx.doi.org/10.1007/s00203-014-0981-3>.
- Fast, P.G., 1972. The 6-endotoxin of *Bacillus thuringiensis* III. A rapid method for separating parasporal bodies from spores. J. Invertebr. Pathol. 20, 139–140.
- Feitelson, J., 1993. The *Bacillus thuringiensis* family tree. In: Kim, L. (Ed.), Advanced Engineered Pesticides. Marcel Dekker, Inc, New York, pp. 63–72.
- Ito, Akio, Yasuyuki, Sasaguri, Sakae, Kitada, Yoshitomo, Kusaka, kyoko, Kuwano, Kenjiro, Masutomi, Eiichi, Mizuki, Tetsuyuki, Akao, Michio, Ohba, 2004. A *Bacillus thuringiensis* crystal protein with selective cytotoxic action to human cells. J. Biol. Chem 279, 21282–21286.
- Murty, M.G., Srinivas, G., Bora, R.S., Sekar, V., 1994. A simple method for separation of the protein crystal from *Bacillus thuringiensis* using carboxymethyl cellulose column chromatography. J. Microbiol. Methods 19 (2), 103–110.

- Rivera, D., 1998. Growth Kinetics of *Bacillus thuringiensis* Batch, Fed Batch and Continuous Bioreactor Cultures (M.Sc Thesis) The University of Western Ontario, London, Canada.
- Rolle, Roderick L., 2013. An extensive characterization study of different *Bacillus thuringiensis* strains collected from the Nashville Tennessee area. *Afr. J. Biotechnol.* 12 (30), 4827–4835.
- Schnepf, E., Crickmore, N., Rie, J., Lereclus, D., Baum, J., Feitelson, J., Zeigler, D., Dean, D., 1998. *Bacillus thuringiensis* and its pesticidal crystal proteins. *Microbiol. Mol. Biol. Rev.* 62, 775–806.
- Sharpe, E.S., Nickerson, K.W., Bulla, L.A., Aronson, J.N., 1975. Separation of spores and parasporal crystals of *Bacillus thuringiensis* in gradients of certain X-ray contrasting agents. *Appl. Microbiol.* 30, 1052–1053.
- Sharpe, E.S., Herman, A.I., Toolan, S.C., 1978. Separation of spores and parasporal crystals of *Bacillus thuringiensis* by flotation. *J. Invertebr. Pathol.* 34, 315–316.
- Thomas, W.E., Ellar, D.J., 1983. *Bacillus thuringiensis* var *israelensis* crystal delta-endotoxin: effects on insect and mammalian cells in vitro and in vivo. *J. Cell Sci.* 60 (1), 181–197.
- Zhu, Zhu Sheng, Allan, Brookes, Ken, Carlson, Philip, Filner, 1989. Separation of protein crystals from spores of *Bacillus thuringiensis* by Ludox gradient centrifugation. *Appl. Environ. Microbiol.* 55 (5), 1279–1281.