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Inactivation effects of electrostatic field on *Bacillus subtilis*

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Abstract

In order to study the inactivation effects of electrostatic field of electret films on *Bacillus subtilis*, a plane–plane electrode system was used to simulate the electric field of the electret films and the viability of *B. subtilis* affected by electrostatic field for different applying durations was investigated. It was found that the survival ratio of *B. subtilis* can be considerably affected by the field and duration. It was also found that the viability of bacillus decreases with the increase of the duration. In addition, the comparative survival ratio (CSR) of *B. subtilis* decreases to 35% even during a short duration as the applied field reaches an enough high value of more than 15 kV/cm. These indicated that the uniform field inactivated the viability of *B. subtilis* availability. Based on the inactivation effect of the applied field on the *B. subtilis*, the effectiveness of charged polypropylene films on the inactivation of *B. subtilis* was measured and discussed.

Keywords: Electrostatic field; Inactivation; Survival ratio; Electret

1. Introduction

Severe acute respiratory syndrome, as the major new infectious disease of the century, spread around the world last year. Since the disease badly endangers the

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health of people, it is important to find effective means to prevent and eliminate the virus [1]. Thus, the Natural Science Foundation of China started a research project to study the effectiveness of electret filter on the purpose.

Electret filters have been widely used in industrial application such as particulate respirators and air controllers. The charged fibers shape electrostatic field which improves the filtration efficiency by the electrostatic attraction of particles and microorganism [2]. For more than one hundred years, scientists have reported that direct and alternating electrical currents can kill or inhibit the growth of bacteria and yeast [3]. Many efforts have been made to study the inactivation of microorganism by pulse electric field [4–5]. However, we lack database on the inactivation mechanism of bacteria and virus by electret filters which are of stable value to the electrostatic field.

In this paper, plane–plane electrode system was used to study the inactivation effect of electrical field on microorganisms. *Bacillus subtilis* as the experimental microorganism was dealt with different applying fields and actuation durations. The polypropylene (PP) films, known as one kind of electret media, were charged and used to deal with *B. subtilis* directly. Comparison between the inactivation effects of both the electrostatics field and charged electret films on the viability of *B. subtilis* was studied.

2. Experiments

2.1. Samples and setup

A stainless-steel plane–plane electrode system was used to provide uniform electrostatic field. One of the electrodes was linked to positive high voltage while the other was grounded.

B. subtilis was supplied by Food Science & Nutritional Engineering College of China Agricultural University. It was prepared by inoculating a loop of bacteria from a mother dish into 100 cm^3 of nutrition broth. The nutrition broth was placed in a constant temperature incubator of 37 °C for 16 h before the experiments. The PP films, with 32 mm diameter and 80 μm thickness, were charged by needle-plane electrode system for 3 min under room conditions and the net charge density was measured by an electrostatic charge meter. As the PP film has good hydrobolicity, the *B. subtilis* suspension was not easy to cover the PP surface uniformly, some changes were made to modify the wettability. The changes had not affected the conductivity and pH value of bacterial solution.

2.2. Procedures

There were three key processes in the experiments. (1) Put diluted *B. subtilis* suspension on the glass slice or PP film, and make them uniformly cover the slice or film; (2) Place the glass slice between the plane electrodes with or without applied voltage for some duration. The glass slice was put into sterile water and the solution