Low energy electron beam (LEEB) as alternative nonthermal decontamination technology for dry food surfaces

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Dry food products are often highly contaminated, and resistant microorganisms, such as bacterial spores, can be still viable and multiply if the product is incorporated into high moisture food products or rehydrated. Traditional technologies for the decontamination of these products have certain limitations and drawbacks, such as alterations of product quality, environmental impacts, or carcinogenic potential. Nonthermal low energy electron beam (LEEB) is a promising technology for microbial inactivation on dry food surfaces, which has shown potential to solve these limitations. Due to the limited penetration depth of LEEB (? 300 keV), product-process interactions can be minimized by maintaining product quality. Relevant spore inactivation efficiency supports the application of LEEB. Spores from Geobacillus and Bacillus species were treated with a labscale LEEB at energy levels of 80 and 200 keV. The spore resistances were expressed as D-values (the radiation dose required for one log10 reduction at a given energy level). The results revealed that the spore inactivation efficiency by LEEB is comparable to that of other radiations and that the inactivation curves are mostly log10-linear at the investigated dose range (3.8 – 8.2 kGy at 80 keV; 6.0 – 9.8 kGy at 200 keV). The D-values obtained from the wildtype strains varied from 2.2 – 3.0 kGy at 80 keV, and from 2.2 – 3.1 kGy at 200 keV. Bacillus subtilis mutant spores lacking a/b-type small, acid-soluble spore proteins showed decreased D-values (1.3 kGy at 80 and 200 keV), indicating that spore DNA is one of the targets for LEEB inactivation. The results revealed that bacterial species, sporulation conditions and the treatment dose influence the LEEB inactivation. This finding indicates that for the application of this emerging technology, special attention should be paid to the choice of indicator, physiological state of the indicator and the processing settings. A first demonstrator for LEEB with a capacity of one ton per hour has already been introduced into the food industry for the decontamination of herbs and spices. Proposed inactivation mechanisms, product-process interactions, limitations and upscaling potential, as well as future trends and research needs of this emerging technology will be critically summarized