

Plasma-functionalized water: from bench to prototype for fresh-cut lettuce

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Abstract

Fresh-cut produce like lettuce may contain a very high microbial load, including human pathogens. Therefore, the need for antimicrobial agents at post-harvest stages to mitigate microbial cross-contamination and growth is evident. Sanitation based on non-thermal plasma (NTP) reveals innovative food processing possibilities by application at different points along the food chain, for production, modification, and preservation, as well as in packaging of plant- and animal-based food. The aim of the present study was to evaluate the applicability of plasma-treated water (PTW) as antimicrobial process water additives for washing in fresh-cut lettuce processing. Antibacterial activities of PTW the natural occurring microflora of lettuce were examined. Different process variants of PTW application inside the washing process were investigated. Fresh-cut lettuce were investigated regarding microbiological safety and food quality. Samples were analyzed for antimicrobial and metabolic activity as well as metabolic vitality to prove food safety. The investigations for food quality included color and texture analyses and nitrate concentration detection in fresh tissue as well as microscopic measurements by scanning electron microscopy (SEM) and atomic force microscopy (AFM) for tissue surface structure and transmission electron microscopy (TEM) for cell organelle investigations. The application of PTW allowed up to 5 \log_{10} cycle reduction, depending on the process variant and scale (lab and pilot scale). The increase of antimicrobial activity was accompanied by a reduction of metabolic activity, but not consequently by a decrease in metabolic vitality. Food quality was not affected by the use of PTW in the washing process of the fresh-cut lettuce. The promising results in color and texture were supported by the results of the microscopic assays. These promising results may lead to an industrial application of PTW as process water additive in fresh-cut produce processing to reduce the microbial load on the food surface and in addition in the process water or on food processing surfaces.