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INNOVATION ON THE SURFACE DECONTAMINATION OF FRESH PORK MEAT. TREATMENT WITH COLD PLASMA ACTIVATED WATER

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I. INTRODUCTION

Meat products can become contaminated with various microorganisms, both pathogens and indicators, at any stage of their production. Foodborne diseases (FBD) represent an important public health concern worldwide, so the prevention and control of pathogenic microorganisms in food is essential for the meat industry [1]. Currently, there is a growing interest in surface decontamination of fresh meat. However, the technologies available for this purpose are limited. Among them, the use of plasma-activated water is presented as an innovative alternative, although its direct application on fresh meat is still uncommon in the meat industry. This non-thermal and sustainable disinfection technology has demonstrated efficacy in different sectors of the food industry [2]. Its mechanism of action is based on the application of atmospheric plasma treatment to water, which generates reactive oxygen species (ROS) and reactive nitrogen species (RNS), responsible for bacterial inactivation [3,4].

In this study, the efficacy of plasma-activated water on fresh meat was evaluated to determine its impact on microbial activity and its potential use in the meat industry.

II. MATERIALS AND METHODS

The work was carried out with pork loin and with loin carcass. Approximate pieces of 5 x 5 cm were cut. Each condition was replicated three times. Three strains were selected: *Listeria monocytogenes, Salmonella* spp. and *Escherichia coli O157:H7* to evaluate the antimicrobial effect of plasma-activated water on meat samples surfaces. Meat and rind samples were inoculated by adding 100 µL of each strain.

The plasma-activated water was added to the surface of the previously inoculated samples at different doses to test its antimicrobial effect. The doses used were 250 (treatment 1), 500 (treatment 2) and 750 (treatment 3) µL. Once the plasma-activated water was added, it was left to act for 30 min. To have a starting point, a control treatment was carried out where the samples were inoculated with the different pathogenic strains, but did not have a plasma-activated water treatment. After microbiological analysis and incubation of the plates, the counts of each group of microorganisms were expressed in logarithms of colony-forming units per g of fresh meat sample (log CFU/g) and in colony-forming units per cm^2 of carcass surface area (log CFU/cm^2).

The experimental data were analyzed using the Statgraphics program (version 5.1 Plus, Statgraphics Technologies; Virginia, United States). The mean values were subjected to the Least Significant Difference (LSD) test with $p<0.05$. The data represented in the graphs and figures are expressed as the mean ± standard deviation (SD).

III. RESULTS AND DISCUSSION

For these pathogenic microorganisms, Regulation (EC) 2073/2005 establishes the microbiological criteria applicable to food products, where the result obtained must be “not detected” in 25 g of meat or cm^2 for the surface of the carcass. In this case, a total count of 0 log CFU/g or cm^2 should be obtained to achieve full antimicrobial activity of the plasma-activated water.

Figure 1a shows the results of the three pathogenic microorganisms for fresh loin meat. For the results obtained it can be observed that for *Escherichia coli* with treatment 3 there has been a reduction of 0.54 log CFU/g and for *Listeria monocytogenes* 0.23 log CFU/g. For *Salmonella* spp there was a reduction of 0.20 log CFU/g with treatment 2; the rest of the treatments applied to the fresh meat did not achieve a significant reduction in the microbial load. Figure 1b shows the results obtained on the surface of the loin cortex. In this case the results were more favourable

than in fresh meat. For the results obtained for Salmonella spp. for treatment 2 and 3 there was a reduction in the microbial load of 0.55 and 0.68 log CFU/cm^2 respectively, however, *Escherichia coli* showed a greater reduction for the three treatments applied, highlighting treatment 1 and 3 which reduced the microbial load by 1.07 and 0.80 log CFU/cm^2 respectively. *Listeria monocytogenes* showed a similar behaviour in the three treatments, achieving a reduction of only 20 to 25% with respect to the control sample.

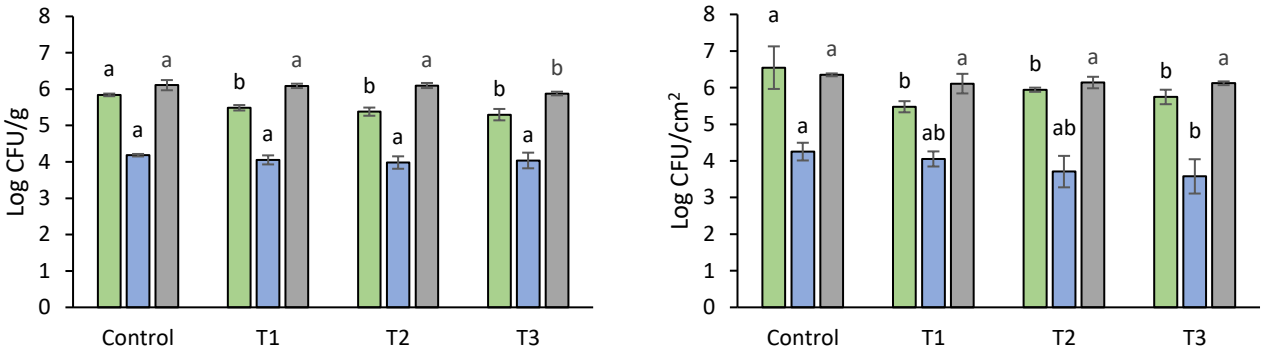


Figure 1. Counts obtained for: ■ *Escherichia coli STEC*; ■ *Salmonella* spp and ■ *Listeria monocytogenes* after application of plasma-activated water in: a) Fresh pork loin meat (log CFU/g); and b) Pork carcass surface (log CFU/cm^2). Different lowercase letters represent significant differences ($p<0.05$) between treatments for each pathogenic microorganism..

Meat is a product with high water activity and a pH and composition that can affect the radicals present in plasma-activated water. It is composed of a large amount of organic matter, such as proteins, fats, blood, etc., so it is possible that the activated water reacts with these compounds and therefore loses its antimicrobial efficacy. It is also possible that the reactive compounds are neutralized or consumed before they can act on the pathogens. Unlike a smooth surface, such as a cutting board, pathogenic microorganisms can penetrate through the interior of the meat, remaining protected within the tissues, muscle fibers or even creating biofilms, which can also cause the activated water to be ineffective.

IV. CONCLUSION

After evaluating the results, it is observed that plasma-activated water loses efficacy when applied to fresh meat. The treatments used failed to significantly reduce the load of *Salmonella* spp, *Listeria monocytogenes* and *Escherichia coli STEC*. Fresh meat and meat surface represent complex food matrices, whose structure and composition may limit the effect of radicals present in plasma-activated water. This suggests the need for further research on complementary strategies to improve antimicrobial efficacy in meat products.

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