Improving the Control of *Listeria monocytogenes* on No-Nitrate-or-Nitrite-Added (Natural or Organic) Frankfurters with Clean Label Antimicrobials

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Summary and Implications

Consumers are critical of the ingredients used in the production of processed meat products. With the increased growth in natural and organic processed meats, suppliers have begun to offer clean label solutions to improve the safety of minimally processed foods. This study investigated the growth of *Listeria monocytogenes* on uncured, no-nitrate-or-nitrite-added frankfurters with or without clean-label antimicrobials, during a 120 day storage period. No-nitrate-or-nitrite-added brands with no antilisterial control measures exhibited a decreased lag time and shorter generation time for initiation of growth, resulting in a greater population of *L. monocytogenes* when compared to the sodium nitrite, sodium lactate/diacetate controls or alternatively cured products with clean label antimicrobials. Results indicate that clean label antimicrobials may serve as an effective intervention strategy for *L. monocytogenes* in the production of uncured, no-nitrate-or-nitrite-added (natural or organic) RTE meat products.

Introduction

Listeria monocytogenes, the pathogen responsible for listeriosis, has emerged as a serious problem in ready-to-eat (RTE) processed meat products. While the occurrence of listeriosis is rare, the illness carries one of the highest mortality rates (~30%) of any foodborne pathogen. In response to outbreaks of foodborne listeriosis, as well as recalls of meat and poultry products adulterated *by L. monocytogenes*, the United States Department of Agriculture (USDA), Food Safety and Inspection Service (FSIS) established a strict "zero tolerance" policy for the presence of *L. monocytogenes* in RTE meat and poultry products. As a result, processors must employ one of three alternatives to control *L. monocytogenes* in RTE meat products. Of these alternatives, organic acids including lactates and diactetates are most commonly utilized as an antimicrobial ingredient in the production of cured meat products, and have been found to provide significant protection against *L. monocytogenes*. Despite the well established impacts on food safety, the use of preservatives, including antimicrobials such as lactate and diacetate, are not permitted in uncured, no nitrate-or-nitrite-added, natural or organic, meat products. These products make use of naturally occurring nitrates and nitrites found in vegetables, to produce products that have typical cured meat characteristics including color and flavor. Even so, these properties are highly variable and have raised concerns for the overall safety of natural and organic RTE processed meats. Previous work indicates that the modifications in ingredients, including lower levels of nitrite and lack of anti-listerial controls, puts uncured, no-nitrate-or-nitrite-added RTE meats at an increased risk for *Listeria monocytogenes* and alternative control measures are warranted.

Materials and Methods

Frankfurter Manufacturing Procedures

Beef and pork frankfurters were manufactured at the Iowa State Meat Laboratory utilizing two alternative curing systems and two clean-label antimicrobial options available to commercial processors. Three batches of frankfurters were manufactured from each curing system, one batch contained no antimicrobial and the second batch contained a blend of cultured corn sugar and vinegar, while the third batch contained a blend of vinegar, lemon powder, and cherry powder. A conventionally cured product that contained sodium nitrite, sodium erythorbate, and a potassium lactate/diacetate blend served as the positive control to demonstrate typical *L. monocytogenes* inhibition. In addition, a negative control was also manufactured and contained no nitrite or antimicrobial interventions. All treatments contained the same level of salt, dextrose, spices and added water. Thermal processing procedures were dependent upon the alternative curing system used. After chilling, frankfurters were vacuum packaged and transported to the Food Safety Research Laboratory for further analysis.

Evaluation of Clean-Label Antimicrobials

Whole frankfurters were aseptically removed from the package and surface inoculated with 1 ml of a 5-strain cocktail mixture of *L. monocytogenes.* Samples were hand massaged for 10-15 seconds to distribute microorganisms, vacuum sealed and stored at 4°C for 120 days. Evaluations were preformed weekly for the first six weeks and bi-weekly for the remainder of the study. Samples were

prepared in duplicate by first blending whole frankfurters with sufficient 0.1% peptone water to achieve a 1:5 dilution of each sample. Appropriate dilutions were then plated on modified oxford media (MOX) and incubated at 35°C for 48 hours to allow for enumeration of *L. monocytogenes*.

Results and Discussion

Figure 1 shows the growth of all treatments over the 120 day sampling period. The positive control, containing sodium nitrite, sodium erythorbate, and potassium lactate/diacetate blend, resulted no detectable growth throughout the challenge study. Furthermore, it is clear that the no-nitrate-or-nitrite-added treatments that contained no antimicrobial interventions (TRTs 1, 4) were unable to repress the growth of *L. monocytogenes* throughout the 120 day sampling period. These treatments mirrored the growth of the negative control which contained no nitrite or antilisterial controls, and both treatments resulted in a final population that was 4-5 log CFU/g greater than that of the conventionally processed control and the alternatively cured products with clean label alternatives. Treatments that contained clean label antimicrobials (TRTs 2, 3, 5, 6) demonstrated superior control in uncured, no-nitrate-or-nitrite-added frankfurters compared to those with no antimicrobial interventions.

These results were similar regardless of the curing system or clean-label alternative that was applied. The results of this study further emphasize the need for additional antimicrobial measures for natural and organic, uncured, no-nitrate-or-nitrite-added RTE processed meats. Clean label antimicrobials offer natural and organic friendly solutions to control *L. monocytogenes* in minimally processed meats through 120 days of storage. In doing so these products allow processors to meet USDA-FSIS regulations for these high risk products and can provide consumers with the level of safety that is expected of conventionally cured meat products.

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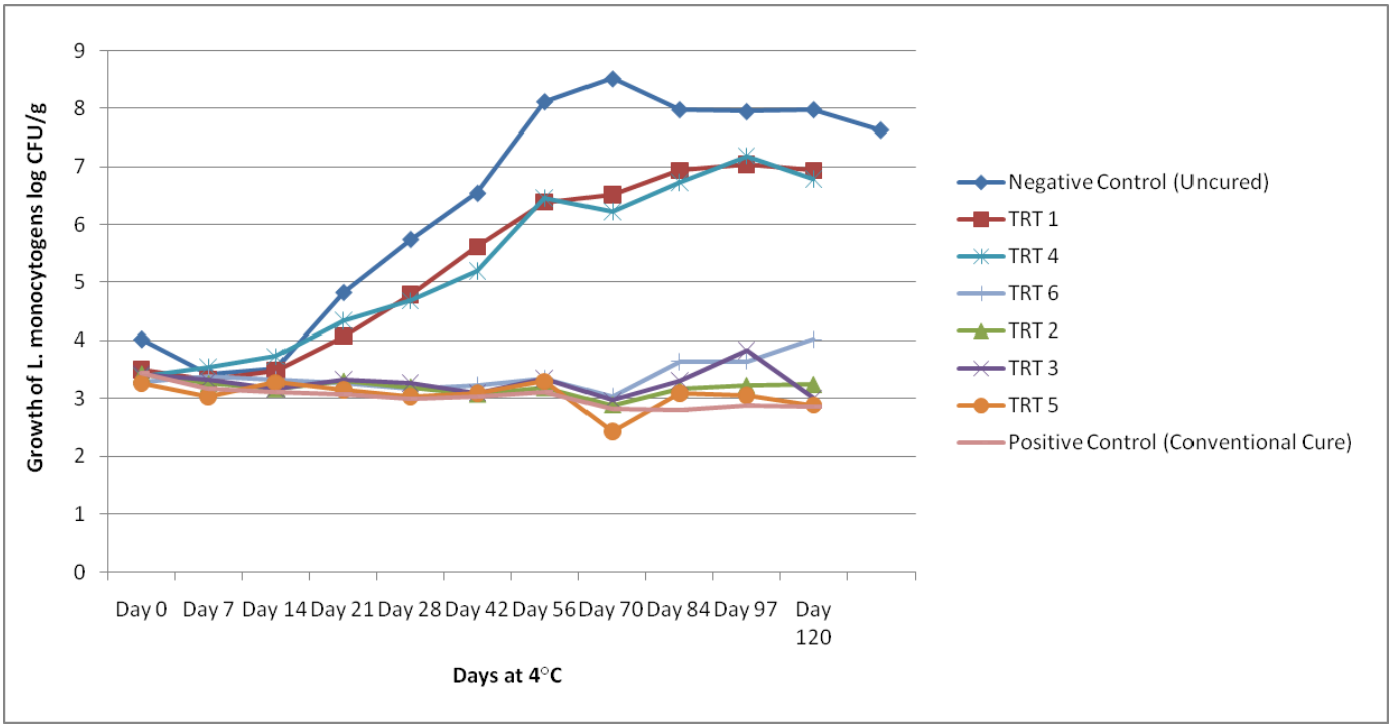

Figure 1. Growth of L. monocytogenes on uncured, no-nitrate-or-nitrite-added frankfurters with and without clean label antimicrobials.