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**EFFICACY OF BUFFERED SODIUM CITRATE ALONE AND IN
COMBINATION WITH SODIUM DIACETATE AGAINST
LISTERIA MONOCYTOGENES ON BEEF FRANKS**

E. Ceylan, M. Hajmeer, and J. L. Marsden

Summary

We assessed the antimicrobial efficacy of buffered sodium citrate alone and in combination with sodium diacetate against *L. monocytogenes* on beef frank samples stored at 39°F. Initial inoculum level of *L. monocytogenes* was 1.5 log colony forming units (CFU)/cm². After 6 weeks of incubation at 39°F, the pathogen reached 5.4 log CFU/cm² in the control sample, but was 1.2 log CFU/cm² and 0.85 log CFU/cm² in samples treated with 1% buffered sodium citrate alone and in combination with 0.1% sodium diacetate, respectively. Use of buffered sodium citrate and the combination of buffered sodium citrate and sodium diacetate should improve safety of ready to eat foods by controlling *L. monocytogenes* during storage.

Introduction

Extending shelf life and assuring safety of meat and poultry products is a high priority. Buffered sodium citrate is a combination of citric acid and sodium citrate. The USDA Food Safety and Inspection Service has permitted the use of buffered sodium citrate since June 24, 1996 in cured and uncured meat and poultry products. Sodium citrate, a salt of citric acid, is approved as a generally recognized safe compound by the Food and Drug Administration. It occurs as a natural compound in fruits and has few limitations for use in food.

Buffered sodium citrate, IONAL™, inhibits its microbial growth and retains flavor. It is especially effective at a low initial microbial count. IONAL increases ionic strength in the system, which allows better water holding capacity, lower water activity, and less purge in meat and poultry products. It increases shelf life and maintains organoleptic characteristics of meat and poultry for a long period of time during storage. The recommended usage level of IONAL is 1.0 to 1.3%. Its antimicrobial activity increases as product pH decreases.

Listeria monocytogenes has been associated with a variety of foods and is designated as a zero tolerance organism in ready-to-eat foods. *Listeria monocytogenes* is Gram-positive, motile with flagella, psychrotrophic, and nonsporeforming. It has been associated with raw milk, pasteurized milk, cheeses, ice cream, vegetables, fermented sausages, raw and cooked poultry, raw meats, and raw and smoked fish. *Listeria monocytogenes* has been isolated from soil, leaf litter, sewage, silage, dust, and water. Its abundance in the environment and ability to grow at temperatures as low as 37°F can cause a serious bacterial infection, listeriosis, in refrigerated and ready to eat foods. Listeriosis has been implicated in approximately 2,500 cases and an estimated 50 fatalities each year. Multistate outbreaks of listeriosis were reported by the Centers for Disease Control and Prevention and the outbreaks caused by consumption of deli turkey meat and hot dogs.

We evaluated the antimicrobial effect of 1% buffered sodium citrate (IONAL) alone and in combination with 0.1% sodium diacetate against *L. monocytogenes* on beef frankfurters during refrigerated storage.

Experimental Procedures

Culture preparation. *Listeria monocytogenes* cultures (ATCC 13932, ATCC 49594, ATCC 43256, ATCC 51414 and ATCC 7647) were obtained from the American Type Culture Collection (Atlanta, GA). Cultures were grown in Brain Heart Infusion broth at 35°C for 24 hours and kept at 39°F until use. Each culture was then transferred from the stock collection and grown at 95°F for 24 hours. Equal volume of each culture was transferred into a sterile test tube to make a mixture of 5 strains of *L. monocytogenes*. Serial dilutions of this mixture were made using 0.1% peptone water (Difco Laboratories, Detroit, MI) and inoculated onto the beef frankfurter samples.

Preparation of beef frank samples. Commercial beef franks were purchased from a local grocery store. The average surface area and weight of beef franks were determined prior to the experiment (n=5). Single beef frank samples were placed into a vacuum packaging bag. Each bag was inoculated with the *L. monocytogenes* mixture. Samples were

surface treated using 1% buffered sodium citrate or 1% buffered sodium nitrate + 0.1% sodium diacetate. Control samples (no antimicrobial treatment) were inoculated only with *L. monocytogenes*. Samples were vacuum packaged, kept at 39°F, and analyzed weekly. *Listeria monocytogenes* count was determined using Tryptic Soy Agar (Difco Laboratories, Detroit, MI) incubated at 95°F for 24 hours. Experiments were repeated three times.

Results and Discussion

The average surface area and weight of beef franks were 91 cm² and 44.8 g, respectively. Initial inoculum level of *L. monocytogenes* was 1.5 log CFU/cm². After 6 weeks of incubation at 35°F, the pathogen reached a 5.4 log CFU/cm² in control samples, but was only 1.2 log CFU/cm² and 0.85 log CFU/cm² in samples treated with 1% IONAL, and the combination of 1% IONAL and 0.1% sodium diacetate, respectively. These results show the potential bacteriostatic and/or bactericidal effect of 1% IONAL and the combination of 1% IONAL and 0.1% sodium diacetate against *L. monocytogenes*. Combining 1% IONAL and 0.1% sodium diacetate might also induce sublethal injury, which would reduce of the number of *L. monocytogenes* on beef frank samples.