Use of Natural Antimicrobials for Inhibition of *Listeria monocytogenes* on Naturally-Cured Frankfurters

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Summary and Implications

Because natural and organic cured meats including frankfurters are not permitted, by regulation, to utilize preservatives, these products may be at greater risk for growth of bacterial pathogens such as *Listeria monocytogenes*. Several natural ingredients have been reported to have significant antimicrobial properties and may offer a means of increasing the safety of natural and organic cured meat products relative to bacterial pathogens. In this study, powdered concentrates from cranberries, cherries, lime and a blend of cherry, lime and vinegar were evaluated alone and in various combinations for antimicrobial impact on the growth of *L. monocytogenes* following the inoculation of naturally cured frankfurters. The results showed that cranberry powder at 3% of the formulation achieved inhibition of *L. monocytogenes* in the naturally cured frankfurters that was equivalent to that of conventionally cured frankfurters during 49 days of refrigerated storage. Cranberry powder at 1% and 2% in combination with other natural antimicrobials inhibited growth for up to 35 days while the naturally cured frankfurters without additional antimicrobial ingredients showed growth after 28 days. However, quality assessment of the products showed that 3% cranberry powder was detrimental to color, sensory and textural attributes of the frankfurters, probably due to the acidic nature of the cranberry concentrate. Addition of phosphate to the formulation increased the product pH but also lessened the antimicrobial impact of the cranberry powder. Consequently, cranberry concentrate has potential as a natural antimicrobial for natural and organic cured meat products but it will be necessary to develop a means of compensating for the acidic nature of this ingredient in order to achieve practical applications in naturally cured meat products.

Introduction

Nitrite is a widely recognized antimicrobial agent used to assure control of many bacteria that have potential to grow on cured meat products. However, USDA regulations do not permit addition of nitrite to natural and or organic processed meats that are normally manufactured with nitrite because nitrite is considered a preservative, and preservatives are not permitted in these products. As a result, alternative methods have been developed for natural and organic processed meats such as frankfurters where a natural source of nitrite in the form of celery powder is used to achieve the expected color, flavor and other properties of cured meats. However, the addition of celery powder typically results in less nitrite than that achieved with conventional curing, and it has been reported that the potential for bacterial growth is greater for the natural and organic processed meat products. *Listeria monocytogenes* is a bacterial pathogen of concern in cured, ready-to-eat processed meats because it is nitrite and salt tolerant and can grow at refrigerated temperatures. Even though *L. monocytogenes* is considered nitrite-tolerant, growth of this organism is slowed by increasing nitrite concentrations and consequently, the reduced amount of nitrite in natural and organic processed meats potentially represents greater risk of this organism on these products. One means of improving the control of *L. monocytogenes* on products manufactured with addition of celery powder for curing would be to include natural ingredients that have significant anti-listerial properties. Several natural ingredients have been shown to impact growth of *L. monocytogenes*. For this study, cranberry, cherry, lime and a commercial blend of cherry, lime and vinegar were used to determine the impact of these ingredients on growth of *L. monocytogenes* when used in naturally cured frankfurters.

Materials and Methods

Naturally cured frankfurters were manufactured for this study using 0.4% celery powder as recommended by the supplier as a source of nitrite for the cure. The celery powder had been processed by the supplier to convert nitrate to nitrite and contained 12,000 parts per million (ppm) of nitrite. This concentration of nitrite when the celery powder was used at 0.4% of the frankfurter formulation resulted in 48 ppm of nitrite added to the frankfurter mixture which is about 1/3 of the normal 156 ppm added in conventional curing processes. Eight treatment groups of frankfurters were produced; negative control with no added nitrite, positive control with only celery powder, conventionally cured control (CC), celery powder with 1% cranberry and 0.6% cherry powder (CB+CP), celery powder with 2% cranberry and 60 ppm lime (CB+LP), celery powder with 3% cranberry (CB), celery powder with a blend of cherry, lime and vinegar (Veg517) and celery powder with 3% cranberry and 0.4% tripolyphosphate (CB+P). All concentrations were determined by preliminary trials. Frankfurters were inoculated with a 5-strain mixture of *L. monocytogenes* at approximately 10^3 cells per gram and stored at 4°C. Growth was monitored every 7 days for 49 days.

Results and Discussion

Growth of the inoculated *L. monocytogenes* did not occur on the conventionally cured control and the frankfurters with celery powder and 3% cranberry powder during the 49 days of storage (Figure 1). The frankfurters with celery powder and 2% cranberry with lime or 3% cranberry with tripolyphosphate, 2% cranberry plus cherry and 2% cranberry plus Veg517 blend all delayed growth for 35 days but the frankfurters with lime and with phosphate grew more slowly after 35 days than did those with cherry powder and the Veg517 blend. The positive and negative controls both showed growth after 28 days and maintained higher number of counts throughout the storage period than all other treatments. Of the ingredients studied, cranberry powder had the greatest impact on growth *L. monocytogenes*. However, un-inoculated frankfurters were also analyzed for chemical, textural and sensory properties and those with 3% cranberry powder were significantly lower in pH (0.73 pH units less than the conventional cure), color (less red), texture (softer) and sensory panel scores (less flavorful). Consequently, while the cranberry powder had the greatest impact on *L. monocytogenes* growth of the ingredients studied, it also seriously affected product quality. Because the quality effects are most likely the result of the acidity of the cranberry powder, it will be necessary to compensate for the pH change if cranberry powder is to be successfully used in frankfurters. In this study, tripolyphosphate was included in one treatment group with cranberry powder to increase product pH and was effective in doing so, but the increased pH also resulted in reduced impact on *L. monocytogenes* growth. If cranberry powder is to be used as a natural anti-listerial agent in frankfurters, it will be necessary to develop a means of reducing the pH impact while retaining the anti-listerial properties of this ingredient.

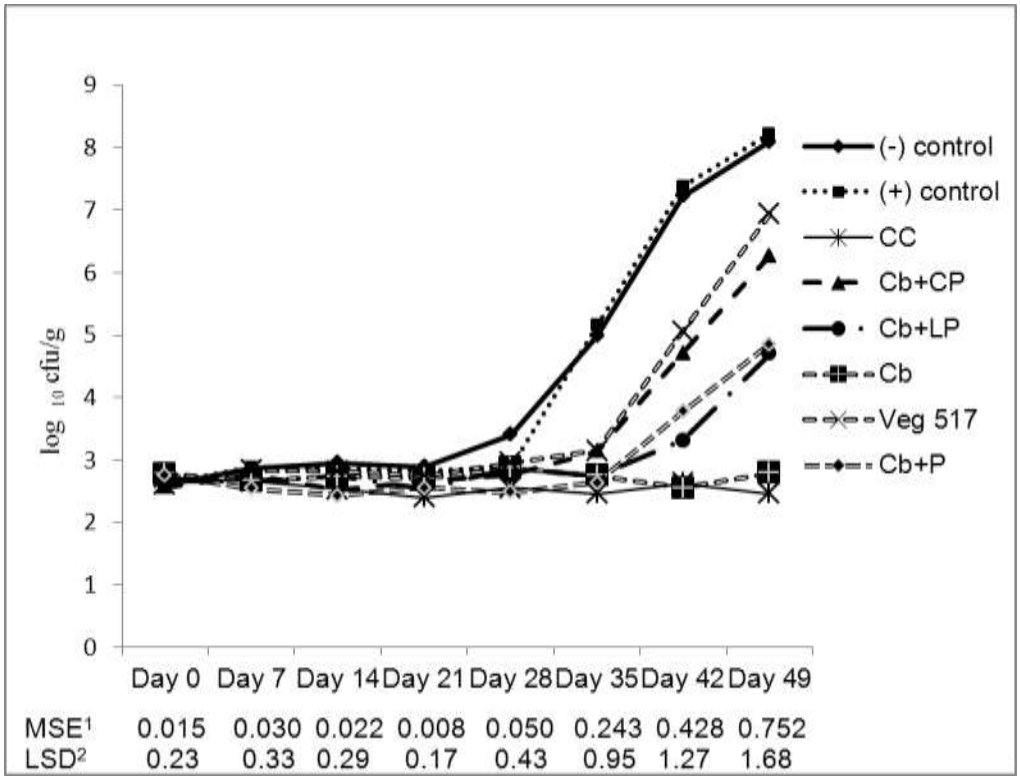

Figure 1. Growth of *Listeria monocytogenes* on inoculated frankfurters with different antimicrobial treatments during storage at 4 °C

(-) control, no nitrite; (+) control, celery powder without added antimicrobials; CC, conventionally cured; Cb + CP, 1% cranberry powder and 0.6% cherry powder; Cb + LP, celery powder, 2% cranberry, and 60 mg/kg lime powder; Cb, celery powder and 3% cranberry powder; Veg 517, celery powder and cherry, lime, vinegar blend; Cb + P, celery powder, 3% cranberry and 0.4% sodium tripolyphosphate.

[1]MSE: Mean Square Error, [2]LSD: Least Significant Difference, expressed for each day.