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The Effects of Source and Amount of Nitrite on Quality Characteristics of All-Beef Frankfurters

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Summary

In an effort to meet consumers' demand for foods with more natural ingredients, processors have begun manufacturing meat products cured with natural nitrite sources. The objective of this study was to evaluate the quality characteristics of all-beef frankfurters cured with traditional or alternative sources of nitrite and using equivalent amounts of nitrite. Frankfurters cured with alternative sources of nitrite had a slightly darker, less red exterior and slightly more yellow interior than those containing sodium nitrite. No differences were observed for pH or water activity. Both curing methods can be used to manufacture all-beef frankfurters with similar characteristics when using equivalent amounts of nitrite.

Introduction

Sodium nitrite alters product color, aroma, and flavor; inhibits the growth of specific pathogens; and reduces lipid oxidation that leads to rancidity in cured meat. There is a customer segment that has become more conscious of ingredients used in processed foods. These consumers are demanding foods with more natural ingredients and fewer overall added ingredients. Sodium nitrate and nitrite, which are commonly used in cured meats, are two major ingredients of concern to this group. This perception stems from research that began in the 1950s indicating sodium nitrate and nitrite may be detrimental to the health of consumers even though some current research sug-

gests dietary nitrate and nitrite may have health benefits. Without the inclusion of sodium nitrite, cured meat flavor, color, aroma, and antimicrobial control is not achievable. In order to maintain cured meat characteristics, meat processors have turned to natural nitrate sources, including celery juice powder, and nitrate-reducing starter cultures to add nitrite from alternative sources than from sodium nitrite. The USDA requires these products to include "uncured" and "no nitrate or no nitrite added except those naturally occurring in [ingredients]" on the label, even though these products have typical cured meat characteristics. To this point, studies comparing the curing methods did not evaluate equivalent amounts of ingoing nitrite from multiple sources. Therefore, the objective of this study was to examine the physical characteristics of all-beef frankfurters manufactured with sodium nitrite or celery juice powder added at equivalent concentrations of ingoing nitrite.

Procedure

This study was conducted in a two-by-four factorial design measuring two different cure methods (sources of nitrite) and four nitrite concentrations (amount of nitrite). The two nitrite sources utilized were sodium nitrite (traditional curing; VegStable 506, Florida Food Products, Inc., Eustis, Fla.). Both sources were evaluated at 0, 52, 104, and 156 ppm ingoing sodium nitrite concentration or the equivalent amount of nitrite from celery juice powder. Additionally, 469 ppm of sodium erythorbate was added to the conventional treatments, and cherry powder (VegStable 515, Florida Food Products, Inc., Eustis, Fla.) was added

to achieve 469 ppm of ascorbic acid in the alternative cure treatments. Frankfurters were manufactured at the University of Nebraska–Lincoln Loeffel Meat Laboratory. Beef trim, 25 lb batches, and non-meat ingredients were added to a bowl chopper and emulsified to a final temperature of 65°F. The emulsion was stuffed into 0.94 inch cellulose casings using a vacuum stuffer. Treatments were placed in a single-truck smokehouse cooked/smoked to an internal temperature of 160°F. Products were then removed from the smokehouse and stabilized overnight in a 30°F cooler. The following day frankfurters were removed from the casings, vacuum packaged, and stored covered under refrigeration (30°F) until the appropriate day of analysis. Analysis was performed for external and internal color using CIE L*, a*, and b* (lightness, redness, and yellowness, respectively); pH on day 0, 14, 28, 42, 56, 70, and 84 and water activity on day 0. Data were analyzed using PROC GLIMMIX procedure of SAS (SAS Institute, Inc., Cary, N.C.).

Results

Exterior and Interior Color

The source of ingoing nitrite (sodium nitrite or celery juice powder) had minimal impact on the physical characteristics of all-beef frankfurters (Table 1). External L* ($P = 0.033$) and a* ($P = 0.021$) values were greater for the frankfurters with sodium nitrite than with celery juice powder, meaning the alternatively cured frankfurters were darker and less red than those cured with sodium nitrite. Also, the alternatively cured frankfurters did indicate a more yellow interior color than the traditionally cured frankfurters, likely due to the inclu-

Table 1. Impacts of source and amount of nitrite on physical characteristics of all-beef frankfurters.

Source of Nitrite	pH	External Color			Internal Color			Water Activity
		L*	a*	b*	L*	a*	b*	
P-value	0.818	0.033	0.021	0.387	0.257	0.204	<0.0001	0.219
Sodium nitrite	6.34	53.89 ^a	18.21 ^a	17.84	64.68	14.89	11.23 ^b	0.971
Celery juice Powder	6.33	53.09 ^b	17.21 ^b	17.41	64.43	14.74	11.98 ^a	0.969

Nitrite Concentration ¹	pH	External Color			Internal Color			Water Activity
		L*	a*	b*	L*	a*	b*	
P-value	0.463	0.015	<0.0001	0.721	0.0003	<0.0001	<0.0001	0.447
0 ppm	6.32	52.85 ^b	11.53 ^d	17.66	65.37 ^a	9.07	12.95 ^a	0.972
52 ppm	6.33	54.16 ^a	17.42 ^c	18.06	64.51 ^b	16.15	10.96 ^c	0.970
104 ppm	6.35	54.03 ^a	20.32 ^b	17.27	64.29 ^b	16.63	11.20 ^{bc}	0.971
156 ppm	6.34	52.91 ^b	21.56 ^a	17.52	64.04 ^b	17.41	11.31 ^b	0.968

^{a-d}Means in the same column with lacking common superscripts are significantly different ($P < 0.05$) for the given trait.

¹Amount of ingoing sodium nitrite or equivalent from celery juice powder.

sion of the celery juice powder and cherry powder ($P < 0.0001$). Nitrite concentration had greater effects on the frankfurters' characteristics. The amount of nitrite had a significant effect ($P = 0.015$) on L* values. Internal color was lighter at 0 ppm ingoing nitrite than all amounts of nitrite ($P = 0.0003$). At the same time, interior color was more yellow at the same concentration (0 ppm) of

ingoing nitrite than for all other concentrations ($P < 0.0001$). There was a significant concentration x day interaction for internal a* ($P = 0.031$). The internal a* did not change for 0 ppm frankfurters over time, whereas all other ingoing nitrite concentrations became less red with storage time. Length of storage also had an effect on the physical characteristics of all-beef frankfurters as well. As the

dark storage time increased, frankfurters became lighter ($P < 0.0001$) for all treatments and ingoing nitrite concentrations. At the same time, all samples exhibited fading of external color as it became less red, as expected ($P < 0.0001$).

Water Activity and pH

Neither source nor amount ($P \geq 0.219$) of nitrite had a significant effect on day 0 water activity. Likewise, source and amount of nitrite had no effects on pH ($P \geq 0.463$). These findings suggest that although minor changes in color can result, alternative curing methods provide similar cured meat characteristics as using sodium nitrite when equivalent amounts of sodium nitrite are added.

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