Use of Nitrite-Embedded Film for Extending the Color Stability and Shelf Life of Alternatively-Cured, Fully Cooked Bologna

A.S. Leaflet R3307

Michael S. Cropp, Graduate Research Assistant, Department of Animal Science; James S. Dickson, Professor, Department of Animal Science; Rodrigo Tarté, Assistant Professor, Departments of Animal Science and of Food Science and Human Nutrition; Joseph G. Sebranek, Distinguished Professor, Departments of Animal Science and of Food Science and Human Nutrition

Summary and Implications

Nitrite-embedded film (NEF) was tested in alternatively-cured bologna to improve the color stability and shelf life. Results showed that alternatively-cured bologna vacuum packaged in NEF provided improved color stability. Additionally, NEF was capable of improving the external surface and internal color of NEF packaged alternatively-cured meats. Furthermore, results indicate that NEF may provide a novel means of generating pigments important to cured meat after thermal protein denaturation.

Introduction

The widespread consumer demand for alternatively-cured meat products continues to rise, due to negative consumer perceptions revolving around nitrate and nitrite. Alternatively-cured meat products typically rely on natural sources of nitrate and/or nitrite, which are generally vegetable-based substitutes. However, there is a greater potential for vegetable-like flavors associated with plant-based nitrite substitutes. Thus, to compensate for potential vegetable-like flavors and aromas; processors typically reduce the vegetable-based curing ingredient concentration, subsequently reducing the amount of ingoing nitrite in alternatively-cured meats. Reduced nitrite concentrations can lead to reduced color stability, especially over extended retail display. Retailers expect to achieve the same color stability in alternatively-cured meats as they do for conventionally-cured meat products. Thus, creating incentives for processors to consider different packaging methods for alternatively-cured meat products. NEF has been shown to extend the color stability of fresh meat (compared to overwrap packaging), however, NEF has not been studied for cured meat applications.

Materials and Methods

Three different product formulations of all-beef bologna were manufactured. The three formulations consisted of a conventionally-cured control (nitrite from Modern Cure with sodium erythorbate: CON-CF) which was vacuum packaged with conventional film, an alternatively-cured bologna formulation utilizing nitrite from cultured celery juice powder and cherry powder with half of the batch vacuum packaged in conventional film (CJP-CF) and the other half vacuum packaged in nitrite-embedded film (CJP-NEF). An additional alternatively-cured formulation was produced using Natpre T-10 EML Plus S (Productos Sur, S.A. (Prosur), San Ginés, Murcia, Spain) ingredient with half of the batch vacuum packaged in conventional film (NT10-CF) and the other half of the batch vacuum packaged in nitrite-embedded film pouches (NT10-NEF). The nitrite concentration for the Modern Cure (CON-CF) ingredient was 62,500 ppm nitrite (NO_2)which resulted in 125 ppm ingoing nitrite for the bologna, the cultured celery juice powder ingredient (CJP-CF, CJP-NEF) contained 22,500 ppm NO_2 which resulted in 79 ppm ingoing nitrite and the Natpre T-10 EML Plus S ingredient (NT10-CF, NT10-NEF) contained 1,700 ppm NO_2 which resulted in 17 ppm ingoing nitrite. After thermal processing and subsequent chilling, the bologna logs were sliced to 6.35mm thick slices and packaged. Four slices were placed into either conventional vacuum packages or nitrite-embedded film vacuum packages and subsequently stored at 1 ± 2°C under simulated, continuous retail display conditions using white fluorescent lights. The packaged samples were held under 2200 ± 500 lux during retail display and sample locations were routinely rotated to provide uniform light exposure. In-package and internal color (CIE L*, a*, b*) measurements were taken at a 10º observer angle using illuminant D65 (daylight at 6500K) with a 2.4 cm aperture size, as well as surface and internal residual nitrite and nitrate was conducted post-packaging on days 1, 6, 13, 27, 41, 55, 69, 83, 97, 111, and 125. Microbial analysis was conducted on days 0, 7, 14, 30, 60, 90, and 120 for both aerobic and lactic acid bacteria populations. The treatments were replicated twice and statistically analyzed using a mixed procedure with the Statistical Analysis System (SAS, v9.4). A Tukey-Kramer pairwise comparison adjustment was used to determine differences between treatments over time with significance determined by a p-values less than 0.05.

Results and Discussions

Table 1 highlights that products packaged in nitrite-embedded film (NEF) resulted in significantly greater ($P < 0.05$) in-package external a* values (improved redness). Both CJP-NEF and NT10-NEF resulted in greater redness in-package surface a* values than their respective vacuum-packed counterparts (CJP-CF and NT10-CF). The CJP-NEF treatment was significantly ($P < 0.05$) redder than the control (CON-CF) despite a lower ingoing nitrite concentration. This demonstrates the potential role for NEF to affect cooked, cured meat color. Results suggests that the

nitrite from the film is providing nitric oxide for the heat-denatured (cooked) myoglobin to generate improved cured color (redness). The results for internal CIE L*, a*, b* measurements for treatment effects are shown in Table 2. The NT10-NEF treatment demonstrated a significantly higher ($P < 0.05$) internal a* value than NT10-CF, showing that the film is capable of having a positive impact on the interior color of the product (i.e. not simply a surface effect). Figure 1 shows the visual color differences between NT10-CF and NT10-NEF unpackaged surface and internal redness between day 1 and 41, highlighting the improvements provided by NEF.

Analyses for external and internal residual nitrite in the slices of the bologna showed that NT10-CF and NT10-NEF treatments had considerably less residual nitrite than other treatments (Figure 2 and 3); however, the film type did not have an impact on residual nitrite. Similarly, residual nitrate (data not shown) was not impacted by film type. Bacterial aerobic plate counts and lactic acid counts showed no growth of spoilage organisms (data not shown).

Table 1. Means for in-package surface color values for bologna treatment effects during lighted display.

	L*	a*	b*
CON-CF	65.09^{b}	13.76^{b}	16.21^{c}
CJP-CF	64.24^{c}	13.56^{b}	17.11^{b}
CJP-NEF	63.99^{c}	14.44^{a}	16.09^{c}
NT10-CF	65.73^{a}	7.34^{d}	20.70^{a}
NT10-NEF	65.71^{a}	12.02^{c}	16.82^{b}
SEM	1.70	0.84	0.09

$^{a-e}$ Means in the same column with different letters are significantly different ($P < 0.05$)
CON-CF = control, conventionally-cured and vacuum packaged in conventional film
CJP-CF = alternatively cured with cultured celery juice powder and vacuum packaged in conventional film
CJP-NEF = alternatively-cured with cultured celery juice powder and vacuum packaged in nitrite-embedded film
NT10-CF = alternatively-cured with Natpre T-10 EML Plus S and vacuum packaged in conventional film
NT10-NEF = alternatively-cured with Natpre T-10 EML Plus S and vacuum packaged in nitrite-embedded film

Table 2. Means for internal color values for bologna in lighted display.

	Internal		
	L*	a*	b*
CON-CF	64.45^{bc}	13.77^{a}	14.78^{d}
CJP-CF	63.79^{c}	13.82^{a}	15.45^{c}
CJP-NEF	63.52^{c}	13.91^{a}	15.34^{c}
NT10-CF	66.49^{a}	7.19^{c}	17.99^{a}
NT10-NEF	65.62^{ab}	10.41^{b}	16.17^{b}
SEM	1.54	0.60	0.13

$^{a-e}$ Means in the same column with different letters are significantly different ($P < 0.05$)
CON-CF = control, conventionally-cured and vacuum packaged in conventional film
CJP-CF = alternatively cured with cultured celery juice powder and vacuum packaged in conventional film
CJP-NEF = alternatively-cured with cultured celery juice powder and vacuum packaged in nitrite-embedded film
NT10-CF = alternatively-cured with Natpre T-10 EML Plus S and vacuum packaged in conventional film
NT10-NEF = alternatively-cured with Natpre T-10 EML Plus S and vacuum packaged in nitrite-embedded film

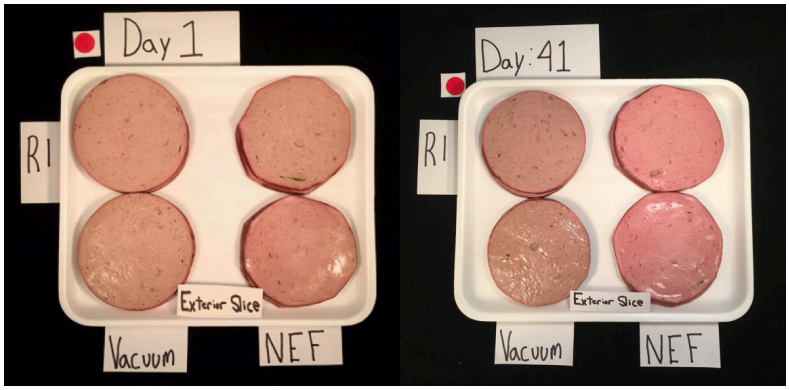

Figure 1. Visual appearance of unpackaged surface appearance of NT10-CF and NT10-NEF treatments opened at day 1 or day 41 of lighted display storage. (NT10-CF = alternatively-cured with Natpre T-10 EML Plus S and vacuum packaged in conventional film
NT10-NEF = alternatively-cured with Natpre T-10 EML Plus S and vacuum packaged in nitrite-embedded film)

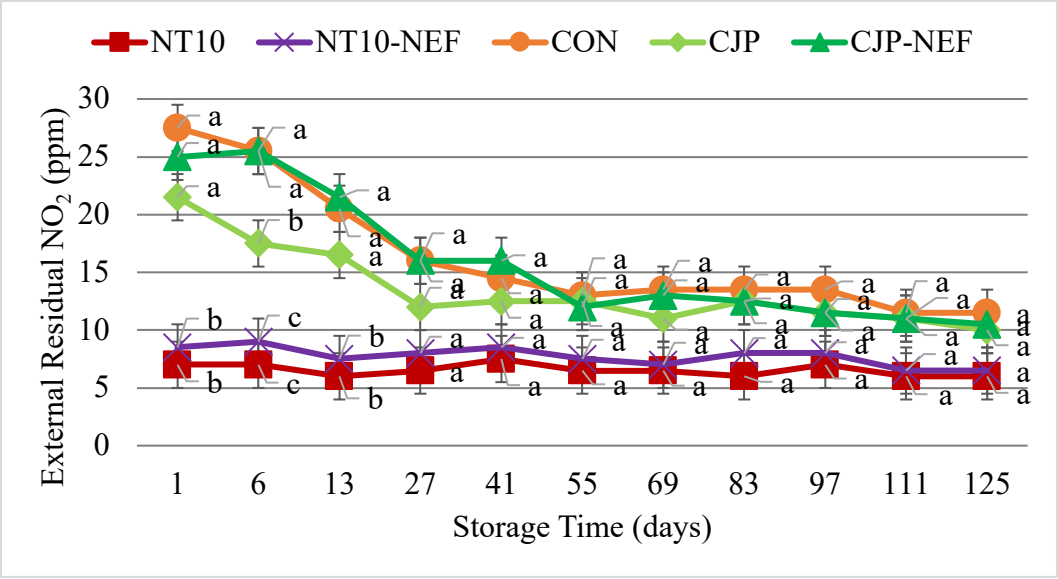

Figure 2. Surface residual nitrite for bologna treatment x day effects under retail display. (SEM = 2.00) [a-c] Means from the same day with different letters are significantly different ($P < 0.05$) (CON-CF = control, conventionally-cured and vacuum packaged in conventional film, CJP-CF = alternatively cured with cultured celery juice powder and vacuum packaged in conventional film, CJP-NEF = alternatively cured with cultured celery juice powder and vacuum packaged in nitrite-embedded film, NT10-CF = alternatively cured with Natpre T-10 EML Plus S and vacuum packaged in conventional film, NT10-NEF = alternatively cured with Natpre T-10 EML Plus S and vacuum packaged in nitrite-embedded film)

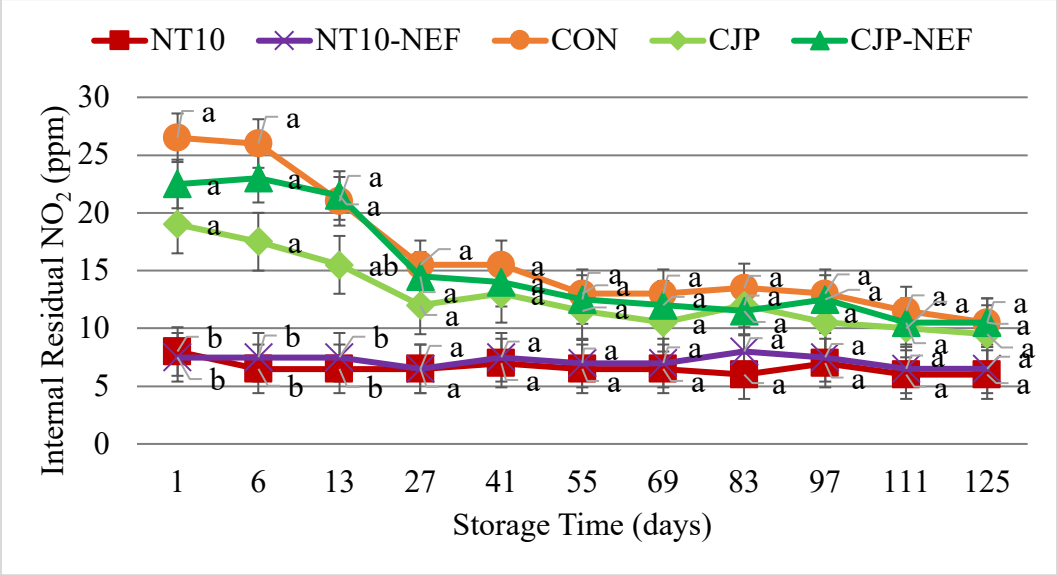

Figure 3. Internal residual nitrite for bologna treatment x day effects in lighted display. (SEM = 2.10) [a-e] Means from the same day with different letters are significantly different ($P < 0.05$) (CON-CF = control, conventionally-cured and vacuum packaged in conventional film, CJP-CF = alternatively cured with cultured celery juice powder and vacuum packaged in conventional film, CJP-NEF = alternatively cured with cultured celery juice powder and vacuum packaged in nitrite-embedded film, NT10-CF = alternatively cured with Natpre T-10 EML Plus S and vacuum packaged in conventional film, NT10-NEF = alternatively cured with Natpre T-10 EML Plus S and vacuum packaged in nitrite-embedded film)