Meat and Muscle Biology™

The Optimization of the Concentrations of Sodium Lactate (Nal), Sodium Erythorbate (Nae), and Sodium Bicarbonate (Nab) Applied to Beef Trimmings for Ground Beef Production

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Objectives

The objective of the study was to identify optimal concentrations of NaL, NaE and NaB applied to beef trimmings to assess their impact on quality of ground beef patties.

Materials and Methods

Beef trimmings (~50kg) were fabricated from beef forequarters ($N = 5$) 14 d postmortem, combined and aerobically stored (5°C) for an additional 6 d to simulate the collection, storage, transportation and receipt of a combo of beef trimmings. A 2^3 central composite response surface design (RSM) was used to generate 15 treatment combinations containing NaL (0.1–1.5 M), NaE (0.1–0.6 M), and NaB (0.1–1.5 M) with water used as a control. After aerobic storage, the beef trimmings (~20% fat) were coarse ground (12 mm) and the treatment/control solution applied to the coarse ground trimmings (~454 g) at 2% (w/w). The trimmings were reground (3 mm) and 120 g of treated sample was placed into a Petri dish and overwrapped with oxygen permeable film (OTR: 21,700 cc/m^2/24h at 25°C) to form patties. The patties (2 per treatment/control) were stored under simulated retail conditions: 5°C, cool white fluorescent light (200–300 lux) and analyzed at Day 0, 3, 6, and 9 of storage to assess the effectiveness of each treatment in preventing further quality deterioration. Objective color (L*, a*, b*), 2-thiobarbituric acid (TBA) determinations, GC–MS for off-odor assessment and aerobic plate counts (APC) were conducted. The least squares means of results were generated by one-way ANOVA and Tukey HSD to identify significant differences ($P < 0.05$) between treatment and control patties. For RSM and multivariate RSM analyses, the data was used to generate total quadratic polynomial linear regression models and contour plots to determine the optimum ingredient concentrations for the solution.

Results

The a* values of treated indicated a redder surface color from Day 0 to Day 9 ($P < 0.05$). No difference was observed for treated and control patties for TBA and hexanal counts on Day 0. The TBA values for all treatments reduced lipid oxidation compared to the control on Day 3, 6, and 9 (0.47– 0.58 vs. 0.71, 0.51– 0.58 vs. 0.74 and 0.45– 0.62 vs. 0.74, respectively; $P < 0.05$). No differences were observed for treated and control patties for APC from Day 0 to Day 6, except on Day 9 (8.10 vs. 8.21 Log_{10} CFU/g; $P < 0.05$). Based on these results, a* and TBA values were used to conduct RSM analyses for Day 3 and 6. Day 9 was excluded due to a significant lack of fit. The predicted value of hexanal was 0 for all treatments. The prediction of TBA values found optimum ingredient concentrations on Day 6: NaL (0.74 M), NaE (0.35 M) and NaB (1.00 M) ($R^2 = 0.77$, respectively; $P < 0.05$). The prediction of a* values on Day 3 and 6 did not identify optimum ingredient concentrations for any treatment solution ($R = 0.94$ and 0.78, respectively; $P < 0.05$). Multivariate RSM was conducted to overlap the contour plots of a* and TBA values at Day 3 and 6 to better approximate the optimal ingredient concentrations for a* values. The proximal optimum concentration ranges of solutions based on the analysis were 0.3-0.5 M NaL, 0.35 M NaE and 1M NaB with predicted a* values > 11 and TBA values < 0.52.

Conclusion

Results of this study suggest that a combination of NaB, NaE, and NaL can be applied to improve color stability, reduce lipid oxidation, and control off-odor of ground beef patties.