QUALITY AND DISPLAY LIFE OF CHILLED OR FROZEN ALL-NATURAL BEEF AND BEEF-BUFFALO FRANKFURTERS

R. Limsupavanich, E.A.E. Boyle, D. H. Kropf, K. A. Hachmeister, T. M. Loughin[1], and M. A. Boland[2]

Summary

Chilled (35±3°F) or frozen (0±3°F) all-natural beef and beef-buffalo frankfurters made with or without sodium nitrite ($NaNO_2$) were evaluated. Treatments included frankfurters made with: all-natural beef without $NaNO_2$ and displayed frozen (B0F); all-natural beef and buffalo without $NaNO_2$ and displayed frozen (BU0F); all-natural beef with $NaNO_2$ and displayed frozen (BNF) or chilled (BNC). Batter pH, smokehouse yield, and proximate analysis were determined. No differences (P>.05) were noted in batter pH, smokehouse yield, proximate analysis, or cooking yield. Day of display had no influence (P>.05) on oxidation. However, BU0F had the highest (P<.05) oxidation value, a measure of potential rancidity. For all treatments, instrumentally measured lightness increased during display, while redness decreased. Both B0F and BU0F had lower (P<.05) redness and nitrosoheme pigments than BNC. Purge loss increased (P<.05) with longer display. Microbial counts and pH of frozen products were not different (P>.05) during display. Nitrite-free frankfurters can be displayed frozen up to 90 days based on microbial counts, but display life may be limited to 60 days by product color. Inclusion of buffalo did not influence physical or microbiological quality of nitrite-free frozen frankfurters but may accelerate oxidative rancidity.

(Key Words: All-Natural Beef-Buffalo Frankfurters, Nitrite-Free, Chilled Display, Frozen Display.)

Introduction

About 834 million lb of frankfurters were sold at retail in the U.S. in 1998, with a value of $1.5 billion. Some consumers perceive "natural" foods as "health" foods. From 1987 to 1994, the sale of "natural" foods increased more than 100%, indicating increased demand. "Natural" beef is minimally processed and contains no artificial additives. Buffalo (*Bison bison*), an alternative red meat, is gaining acceptability in some foodservice settings. All-natural beef or beef-buffalo frankfurters may provide a niche market for meat processors and additional market opportunities for beef. Our objective was to evaluate chilled (35±3°F) or frozen (0±3°F) display life and quality of regular and nitrite-free all-natural beef and beef-buffalo frankfurters.

Experimental Procedures

Ground lean beef (80/20), ground fat beef (50/50), ground lean buffalo (90/10), and all-natural wiener seasonings were obtained from commercial suppliers. Frankfurters were processed by a very small commercial meat processor. They were made with all-natural beef without sodium nitrite ($NaNO_2$) and displayed frozen (B0F); all-natural beef and buffalo (10% of lean component) without $NaNO_2$ and displayed frozen (BU0F); all-natural beef with $NaNO_2$ and displayed frozen (BNF) or chilled (BNC). Each of three processing days represented one replication.

[1]Department of Statistics.

[2]Department of Agricultural Economics.

Frozen raw meat materials, tempered overnight at 32°F, were chopped with seasoning mixes, ice, and $NaNO_2$ and sodium erythobate as appropriate to form a good batter. Batters were stuffed into sheep casing, hand linked (6-in. long), and hung. Frankfurters were smoked (45 min) to an internal temperature of 156°F. After smoking, frankfurters were cooked in hot water (162°F) to 158°F internally, cooled in 84°F water for 20 min, and dried at 32°F for 30 min. Frankfurters were vacuum packaged (5 per bag), labeled, and transferred in a cooler with ice packs to Kansas State University. One package per treatment was selected for instrumental color measurement. After the initial measurement, all samples were displayed under 150 ft-candles of deluxe warm white fluorescent light. The B0F, BU0F, and BNF were displayed frozen (0±3°F), and BNC was displayed chilled (35±3°F) in an open-top display case. Because of limited space, samples were shingle displayed, except those selected for instrumental color measurement.

Purge loss, cooking yield, 2-thiobarbituric acid reactive substances (TBARS), instrumental color, and nitrosoheme pigments were determined initially and at 3, 7, 14, 21, 30, 60, and 90 days. Aerobic plate count (APC), lactic acid bacteria (LAB), *Escherichia coli* (*E. coli*) and coliforms were evaluated initially before display and at 30, 60, and 90 days. Frankfurter pH was measured from the homogenate prepared for microbiological analysis. Data were analyzed as a randomized complete block design with repeated measures using ANOVA methods with the mixed procedure of SAS.

Results and Discussion

No differences ($P>.05$) were noted in batter pH (5.86-5.98), smokehouse yield (95.8-96.3%), protein (13.0-13.4%), fat (18.1-18.9%), or moisture (61.1-61.8%). Day of display had no influence ($P>.05$) on oxidative rancidity measured by TBARS (Fig. 1). Up to 30 days, BU0F had the highest ($P<.05$) TBARS. This might be due to the higher amount of unsaturated fatty acids in buffalo meat compared to beef. At days 60 and 90, the levels were lower and similar to those of B0F. In all treatments, L* (instrumentally determined lighter color) increased with display (Fig. 2). After 14 days, the frozen treatments (B0F, BU0F, and BNF) tended to be much lighter than the chilled treatment (BNC). Instrumentally determined a* decreased (less red) with display (Fig. 3). Treatments with $NaNO_2$ (BNF and BNC) were redder ($P<.05$) than those without $NaNO_2$ (B0F and BU0F). Instrumentally determined b* of frozen treatments decreased (less yellow) with display (Fig. 4). As expected, treatments with $NaNO_2$ had higher cured color intensity than those without $NaNO_2$ (data not shown, reflectance ratio of 650/570). Cured color intensity decreased with display. Cured color of treatments with $NaNO_2$, whether displayed frozen or chilled, was not different. In all treatments, purge loss increased ($P<.05$) with display (Fig. 5). Cooking yield (100.1-100.6%) was not influenced ($P>.05$) by treatment or day. Through 90 days, all frozen treatments had low APCs (1.3-1.5 log CFU/g, Fig. 6). After 30 days, BNC had higher ($P<.05$) APC than frozen treatments. Similarly, lactic acid bacteria of BNC were high ($P<.05$) after 30 days but low (1.0 log CFU/g) in all frozen treatments up to 90 days (Fig. 7). *E. coli*/coliforms of all treatments were estimated <1.0 log CFU/g. Frozen treatments had no differences in pH (6.20-6.36) during 90 days (data not shown). pH of BNC started to drop after 21 days because of the acids produced by LAB.

Nitrite-free beef or beef-buffalo frankfurters can be displayed frozen up to 90 days, based on microbial counts; however, display life was limited to 60 days by product color. Inclusion of buffalo in the formulation did not improve or adversely affect physical or microbiological quality of nitrite-free frozen frankfurters. However, the addition of buffalo meat may accelerate oxidative rancidity increases of nitrite-free frozen frankfurters.

Table 1. Frankfurter Formulation

Item	BOF & BUOF	BNF & BNC
Lean (%)	47.8	47.5
Fat (%)	28.5	28.5
Ice (%)	19.1	19.0
Non meat materials (%)	4.6	5.0

BOF = Beef without $NaNO_2$ and displayed frozen.
BUOF = Beef-buffalo without $NaNO_2$ and displayed frozen.
BNF = Beef with $NaNO_2$ and displayed frozen.
BNC = Beef with $NaNO_2$ and displayed chilled.

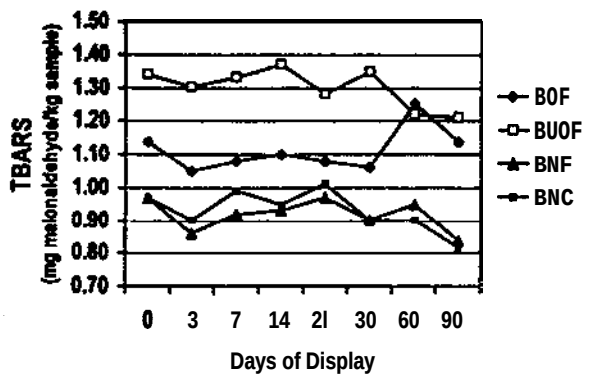

Figure 1. TBARS of Frankfurters during Display.

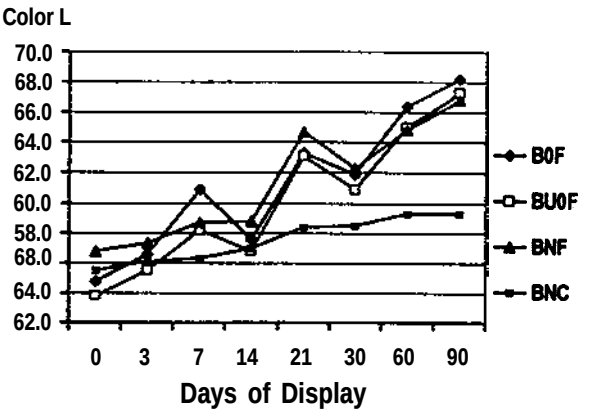

Figure 2. Color L* of Frankfurters during Display.

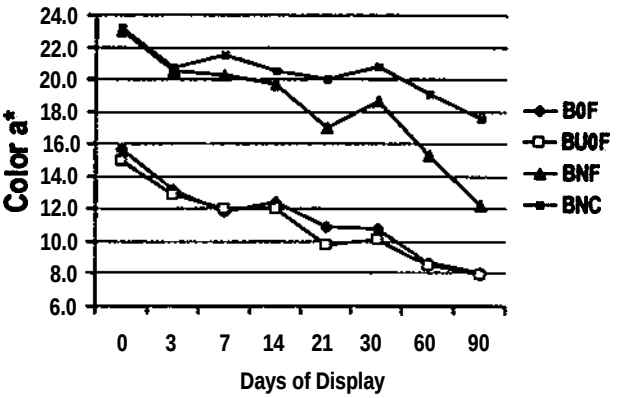

Figure 3. Color a* of Frankfurters during Display.

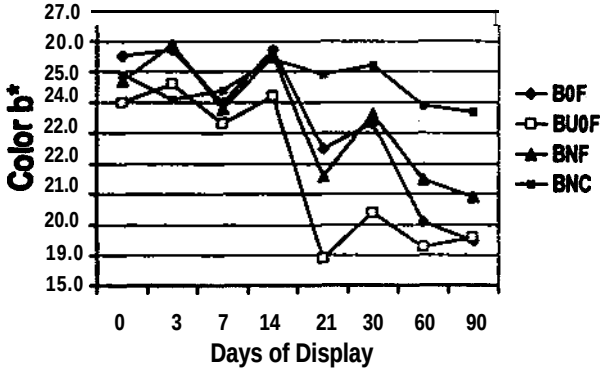

Figure 4. Color b* of Frankfurters during Display.

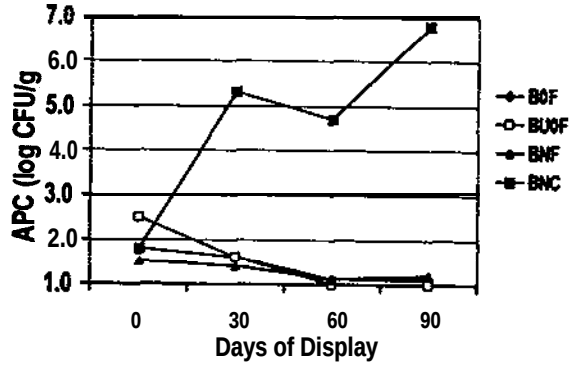

Figure 6. Aerobic Plate Count (APC) of Frankfurters during Display.

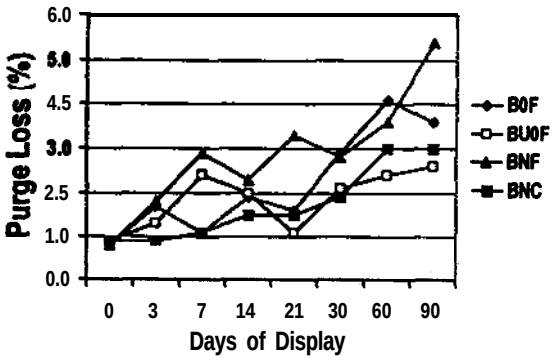

Figure 5. Purge Loss of Frankfurters during Display.

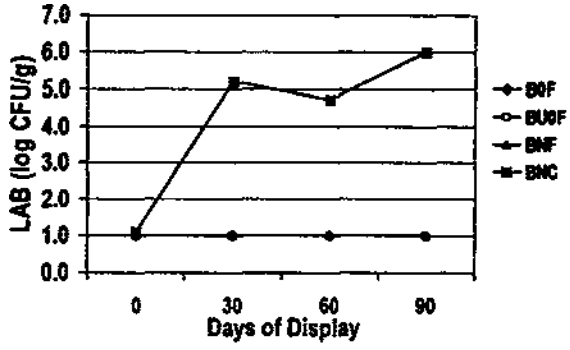

Figure 7. Lactic Acid Bacteria (LAB) Count of Frankfurters during Display.