MICROBIOLOGICAL CONDITION AND DISPLAY QUALITY OF RETAIL STEAKS AS AFFECTED BY INTERVENTION TREATMENTS OF VACUUM PACKAGED BEEF SUBPRIMALS STORED AT DIFFERENT TEMPERATURES

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SUMMARY

Aerobic plate counts (APC's), presence/absence of Listeria monocytogenes and Salmonella spp., and instrumental and visual color evaluations were used to determine the microbiological and display quality of steaks fabricated from beef strip loins sprayed with lactic acid (1.5% v./v) or water before, after, or both before and after vacuum storage of 0, 14, 28, 56, 84, or 126 days at either –1.1° or 2°C. Lactic acid applied pre- and post-storage at –1.1°C yielded the greatest reductions in APC's of steaks displayed for 5 days. L monocytogenes and Salmonella spp. were absent from all steaks. Lactic acid caused more rapid color deterioration resulting in shorter storage- and display-life for acceptable steaks.

Introduction

Todd (1989) estimates the cost of foodborne illnesses to be $8 billion annually in the U.S. alone. Contamination of beef during slaughter and processing is inevitable. In addition to concerns about food safety, high numbers of bacteria can have detrimental effects on sensory qualities of retail beef. Organic acids, such as lactic and acetic acids, have reduced microbial loads when sprayed on carcasses (Dickson and Anderson, 1992; Hamby et al., 1987; Kenney et al., 1992; Prasai et al., 1991; Prasai et al., 1992). However, Kenney et al. (1992) and Prasai et al. (1991; 1992) found that microbial reductions due to acid decontamination of carcasses did not carry through to fabricated subprimal cuts.

The objective of this study was to determine the effects of lactic acid or water sprays applied to vacuum stored beef strip loins before and/or after vacuum storage and temperature of storage on microbiological and display quality of retail steaks.

Materials and Methods

A total of 36 strip loins in each of three replicates were taken from a commercial processing line during the first 4 hours of a daily fabrication shift. Each loin received two treatments, one for each half loin strip. Each replicate was treated as follows: I) Twelve loins were vacuum packaged and stored at –1°C (6 loins) or 2°C (6 loins) for 14, 28, 56, 84, or 126 days or not stored (0 days). On each specified day, a 1.5% lactic acid solution (approximately 725 ml per loin) was sprayed on one half of each loin as a second treatment. II) Another group of 12 loins was sprayed with acid solution prior to vacuum packaging followed by storage and a second treatment with acid in the same manner as described in I. III) The last group of 12 loins was treated the same way as in II, except that the second treatment applied to the other half of each loin was water spray instead of acid. These three treatment groups yielded these different treatment combinations: vacuum-packaged control (C), acid treatment only after vacuum storage (CA), acid treatment before vacuum storage (Aw, Aa), acid treatment before and after vacuum storage (AA), and acid treatment before storage and sprayed with water after storage (AW).

Strip loins received initial treatments and were then vacuum packaged in B-620 oxygen barrier shrink bags (oxygen transmission rate 30 to 50 cc/m^2/24 hour/atm at 22.8°C) using a Cryovac 8300 packaging machine.

On the specified day of storage (0, 14, 28, 56, 84, or 126 days), a strip loin from each treatment pair was randomly selected from each storage temperature and processed, one at a time, in a refrigerated (9 ± 1°C) fabrication room. Three 2.54 cm thick steaks were cut avoiding end surface, placed individually on

Styrofoam™ trays with absorbent pads and packaged with highly oxygen permeable polyvinyl chloride (PVC) film. The knife used during fabrication was sterilized with 95% ethanol and dried between strip loins of different treatments. Strip loins and steaks were handled with sterile surgical gloves. The remaining portion of the strip loin then received the second treatment of the treatment pair it was assigned to (either acid or water spray) and then three more steaks were fabricated and packaged as described.

The three steaks fabricated from each strip loin half were assigned to three retail display periods (0, 3, and 5 days). Steaks were displayed in open-top retail cases at 2 ± 2°C under continuous 1076 lux Warm White Deluxe fluorescent lighting. Positioning of steaks from different treatments within the display case was randomized. On the specified day, steaks were removed from display for microbiological sampling. Two 3.81 cm diameter cores providing 45.6 cm total surface area were excised from each steak for aerobic plate count (APC), placed in a Stomacher bag with a filter with 25 ml Universal Preenrichment Broth (Bailey and Cox, 1992) and pummeled for 30 seconds. Ten fold serial dilutions were prepared using sterile .1% peptone solution. APC's were obtained by pour plate and/or spiral plate methods. Plates were incubated at 32°C for 48 hours before enumeration. Pour plates were enumerated manually with the aid of a Darkfield Quebec® Colony Counter and spiral plates were enumerated using either a Laser Colony Scanner or a Manual Spiral Colony Counter. Modified USDA-FSIS procedure for isolation and identification of Listeria monocytogenes was followed and Salmonella testing used universal pre-enrichment broth with oxyrase, incubation in tetrathionate and selenite cystine broths, transfer to Lysine Iron agar and Triple Sugar Iron agar slants followed by biochemical confirmation.

All color measurements and evaluations were conducted only on the longissimus muscle of steaks assigned to 5 day retail display. On days 0 (before exposure to light), 3, and 5 display, a seven member experienced panel visually scored "average" and "worst point" color to .5 point increments on a five point scale: 1 = bright red, 2 = dull red, 3 = slightly dark red or brown, 4 = dark red or brown, and 5 = very dark red or brown. A "worst point" evaluation was not made unless the area of discoloration was a least 2 cm diameter.

On the same days, CIE L**a*b* (CIE, 1976) values and percent reflectance at 10 nm intervals (520 nm to 630 nm) were obtained with a Hunterlab Labscan 2 spectrophotometer using a 66 mm aperture. Readings of three different longissimus locations of each steak were averaged. The difference between percent reflectance at 630 nm and percent reflectance at 580 nm (R630 nm to R580 nm) was used to estimate oxymyoglobin (Harrison et al., 1980; Hunt, 1980) and the ratio K/S 572 nm/K/S 525 nm was used to estimate metmyoglobin (Stewart et al, 1965). Reflectance at wavelengths not divisible by 10 were estimated by interpolation. Values of .62 and 1.82 were used for 100% and 0% MMb, respectively (Sleper et al., 1983). Procedures of Milliken and Johnson (1984) were used to separate means and correct standard errors.

Results and Discussion

Data from day 3 of display are reported and best show the results. Microbial APCs were influenced by storage time, temperature, and their interaction (Figure 1). The lower temperature (–1°C) resulted in lower counts, especially for steaks from cuts vacuum-stored for 28 days and longer, because of an extended lag growth phase through 28 days of storage. Storage for 56 days resulted in higher numbers of microbes than for 28 days.

Treatment also affected APCs, especially at 28 days for steaks from loins treated with lactic acid before vacuum packaging. Microbial reductions of 2 logs (99%) were shown for the most effective treatments. No microbial counts for steaks displayed for 3 days were unreasonably high. No Listeria monocytogenes or Salmonella spp. were detected on steaks, even after 5 days of display.

Average color score was affected primarily by storage time (Figure 2), because steaks from longer stored subprimal cuts were more discolored (higher score). A color score of 3.5 or higher is considered marginally unacceptable. At the higher storage temperature, the average color score for treatments exceeded this point after storage for 126 days. After vacuum storage for 14 and 28 days, steaks from loins treated with lactic acid were slightly darker in appearance. Instrumental color readings confirmed visual evaluations.

Conclusion

Lactic acid spray of beef strip loins can reduce APC's up to 2 log counts, but results in slightly darker longissimus muscle color.

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