Meat and Muscle Biology™

Investigation of Interrelationships of Spoilage Mechanisms of Aerobically Stored Beef Trimmings

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Objectives

The shelf life of fresh beef trimmings is typically determined qualitatively rather than quantitatively by industry. Shelf life is a function of color stability, lipid oxidation, odors and flavors, and microbial spoilage. The objectives of this study were to determine the number of storage days at which aerobically stored beef trimmings reach the end of shelf life and to increase understanding of the relationships between the mechanisms of spoilage.

Materials and Methods

USDA select *T. brachii* (TB) and *B. femoris* (BF) were sliced to 1.27 cm, placed on plastic trays, covered with O_2 permeable plastic film, and stored at 5°C under fluorescent lighting (150 to 300 lux). On storage d 0, 3, 6, 9, and 12 samples were evaluated for color, pH, volatile compounds, aerobic mesophile (AM), and aerobic psychrotroph (AP) plate counts. L*, a*, b* color was measured, hue angle (HA) and saturation index (SI) were calculated and samples were scanned for spectral reflectance (400 nm to 700 nm) to determine percentage of myoglobin. A modified nitric oxide reducing ability (MNORA) method was used on d 0 through 9 to determine potential metmyoglobin reducing ability (MRA) given the addition of reduced nicotinamide adenine dinucleotide (NADH). To quantify volatile compounds associated with rancidity and other off odors/flavors, headspace volatiles were collected using a solid phase micro extraction field sampler and quantified using GC–MS. Data were analyzed with ANOVA (α = 0.05) using muscle and storage day as main effects. Tukey least squares means were calculated for significant main effects and interactions and mean separations were determined by the PDIFF function. Simple Pearson correlation coefficients were calculated between measured attributes.

Results

The L* values decreased from d 0 (40.74) to d 12 (30.63). The SI values decreased ($p < 0.05$) from d 0 (27.09) to d 12 (11.92). Percent metmyoglobin (MMb) was lowest on d 0 (19.98%) and highest on d 6 (38.75%) and were only similar ($p < 0.05$) on d 9 and 12. The a* values for both muscles decreased ($p < 0.05$) from d 0 (BF 20.84; TB 20.75) to d 12 (BF 8.83; TB 6.93). The pH increased ($p < 0.05$) for both *TB* and *BF* from d 0 (BF 5.51; TB 5.63) to d 12 (BF 6.62; TB 6.79) pH was higher ($p < 0.05$) for TB on all days. Relative MRA declined over storage time though values on d 0 (56.99%) and 3 (64.57%) were higher ($p < 0.05$) than on d 6 (40.12%) and 9 (29.07%). Of the headspace volatiles, only total alcohols increased significantly ($p < 0.05$) from 57,791 on d 0 to 265,152 on d 12. The AM and AP both increased ($p < 0.05$) from d 0 to d 12, reaching 7 $\log_{10}$ CFU/cm^2 by d 9. Significant ($p < 0.001$) correlations were present between pH and color attributes (pH:L*, $r = -0.83$; pH:a*, $r = -0.74$; pH:SI, $r = -0.86$). a* values correlated ($p < 0.001$) with both AM ($r = -0.84$) and AP ($r = -0.71$). Total alcohols highly correlated with both AM ($p < 0.01$, $r = 0.52$) and AP ($p < 0.001$, $r = 0.58$).

Conclusion

The end of shelf life was determined to be d 6 for color attributes and d 9 for microbial growth and off odors/flavors. Pearson correlations showed strong evidence of interrelationships between color, pH, and microbial growth on aerobically stored beef trimmings. This study was the initial phase of a project that will focus on strategies to extend shelf life of fresh beef trimmings by improving color after d 6 and preventing further microbial growth and off odor/flavor development at d 9.