



Impact of Myoglobin Oxygenation State at Freezing on Color Stability of Frozen Beef

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Objectives

Meat color is the number one factor influencing consumer purchase decisions. The emerging market of frozen meat emphasizes the need to understand beef surface discoloration and the ideal parameters of freezing beef to retain a superior color. Therefore, the objectives of this study were to determine the impacts of oxygenation level and frozen storage duration on frozen beef color.

Materials and Methods

USDA Choice strip loins ($n = 36$) were aged for 4 d or 20 d. Steaks were randomly assigned to a myoglobin state [deoxymyoglobin (DeOxy; immediately packaged), low oxygenation (LoOxy; oxygenated in air for 30 min), and high oxygenation (HiOxy; packaged for 24 h in 80% O₂)]. Steaks were then vacuum packaged in oxygen permeable or impermeable film and immediately frozen (-20°C). Following either 0, 2, 4, or 6 mo of frozen storage, steaks were removed from the packaging and immediately analyzed for instrumental color (L^* , a^* , b^*), delta E (magnitude of difference in the L^* , a^* , b^* color space), subjective discoloration, lipid oxidation (via thiobarbituric acid reactive substances- TBARS), oxygen penetration, percent oxymyoglobin, metmyoglobin, and deoxymyoglobin (via spectrometer), and redness (calculated as $630\text{nm}/530\text{nm}$). Data were analyzed using PROC Glimmix procedure in SAS as a split-split-plot with an incomplete block and a 2×3 factorial.

Results

HiOxy steaks had greater oxygen penetration and the highest a^* values compared to DeOxy and LoOxy steaks regardless of packaging ($P < 0.0005$). Conversely, DeOxy steaks exhibited the lowest oxygen penetration and a^* values regardless of film ($P < 0.0005$). HiOxy steaks at 4 d

had higher a^* values than DeOxy and LoOxy at all storage times ($P = 0.0118$). HiOxy steaks had the highest delta E values compared to DeOxy and LoOxy in permeable packaging and with increasing storage time an increase in delta E for the HiOxy steaks was observed ($P = 0.0010$).

Redness and percent oxymyoglobin were highest for HiOxy steaks within each storage period ($P < 0.0002$). HiOxy and LoOxy steaks were similar in percent oxymyoglobin when in permeable packaging film. HiOxy steaks had the highest percent oxymyoglobin and DeOxy had the lowest percent oxymyoglobin within each aging and storage period ($P < 0.01$). Conversely, DeOxy steaks had the highest percent metmyoglobin and HiOxy had the lowest percent metmyoglobin when packaged in impermeable film ($P < 0.0001$). Lowest percent metmyoglobin values were from the 4 d HiOxy steaks at 2, 4, and 6 mo of storage ($P = 0.0188$).

The HiOxy 20 d steaks had the highest discoloration compared to 4 d aging and more discoloration than all other myoglobin treatments at 6 mo of storage ($P < 0.0001$). Lipid oxidation increased with storage time ($P = 0.0169$). HiOxy 20 d aged steaks exhibited the highest TBARS values at 2, 4, and 6 mo ($P = 0.0224$). HiOxy and LoOxy were similar in discoloration and lipid oxidation except with the HiOxy 20 d (which were less desirable).

Conclusion

HiOxy steaks exhibit a brighter and deeper cherry red color compared to the DeOxy steaks. HiOxy steaks were superior or similar when compared to LoOxy steaks but displayed more detrimental effects when frozen storage was extended. Based on the results, HiOxy steaks aged for 4 d give a superior red color for extended storage with few unfavorable effects. However, it is not advised to freeze deoxygenated steaks and expect a cherry red color through frozen storage.