Effects of Light on Non-Enzymatic Metmyoglobin Reduction *in-vitro*

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Introduction: Predominant oxymyoglobin imparts consumer-preferred bright-cherry red meat color, but discoloration on meat negatively impacts purchasing decisions, which can lead to food waste. Discoloration occurs by the oxidation of oxymyoglobin, forming metmyoglobin, a brown pigment. Oxidation can occur more readily in common retail settings such as exposure to light and oxygen (O_2); however, meat has an inherent ability to reduce the brown pigment and form the cherry-red color through metmyoglobin reducing systems. Research indicated inherently present electron donors and carriers could contribute to non-enzymatic metmyoglobin reduction. However, limited knowledge is available on the impact of light on non-enzymatic reduction.

Purpose: The objective of this study was to evaluate the effect of light and dark storage conditions on non-enzymatic metmyoglobin reduction *in-vitro*.

Methods: Solutions of ascorbate and nicotinamide adenine dinucleotide (NADH) were used as electron donors and cytochrome *c* and methylene blue as the electron carriers. Equine metmyoglobin solution at pH 5.6 was combined with different electron donors and carriers in a 96-well plate. To evaluate lighting effects, the well-plate was kept under light-emitting diode (LED) lighting conditions, and readings were taken every 5 min for 25 min using a spectrophotometer set at 582 nm. The same combinations were evaluated in dark storage with the previously mentioned method. The experiment was replicated three times, and the data were analyzed using the Mixed Procedure of SAS.

Results: There was a significant treatment × lighting effect on the metmyoglobin reduction. The combination of NADH and methylene blue had an increase ($P < 0.0001$) in metmyoglobin reduction in light conditions compared to dark storage. Furthermore, in the presence of light, NADH + methylene blue + EDTA had an increase ($P < 0.0001$) in metmyoglobin reduction. The metmyoglobin reduction was limited in the presence of NADH + cytochrome *c* in both lighting conditions. Metmyoglobin reduction was significantly higher in the presence of cytochrome *c* and ascorbate compared with cytochrome *c* and NADH for light and dark conditions. In addition, metmyoglobin reduction increased with the presence of light and the combination of ascorbate and methylene blue ($P < 0.001$).

Significance: The reduction of metmyoglobin in the presence of NADH alone significantly increased in light conditions. In conclusion, the current *in-vitro* research demonstrates inherently present electron donors and carriers can contribute to non-enzymatic metmyoglobin reduction in retail light settings and meat pH.

Keywords: metmyoglobin reducing ability, meat color, myoglobin