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Comparison of Myoglobin, Hemoglobin, and Cytochrome C Oxidation Properties

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Objectives

Myoglobin is the primary sarcoplasmic protein responsible for beef color. However, hemoglobin and cytochrome *c* also contributes to a lesser extent. The redox form of myoglobin can influence beef color. For example, the presence of predominant oxymyoglobin form can impart bright red color while deoxymyoglobin can give dark-red color. The oxidation of deoxy- and oxymyoglobin can result in brown metmyoglobin. Previous research has noted that oxidation processes in meat can accelerate protein and lipid oxidation. However, limited studies have compared oxidation properties of all 3 proteins that can contribute to beef color. Therefore, the goal of this study was to determine hemoglobin, myoglobin, and cytochrome *c* oxidation *in-vitro*.

Materials and Methods

Equine myoglobin, bovine hemoglobin, and bovine cytochrome *c* (0.15 mM) were reduced separately by sodium hydrosulfite. Following reduction, all 3 proteins were passed through PD-10 desalting columns to remove residual hydrosulfite. The concentration of myoglobin, hemoglobin, and cytochrome *c* was confirmed using absorbance at 525 nm. Oxyhemoglobin, oxymyoglobin, and reduced cytochrome *c* were incubated at 4 and 25°C, and the oxidation properties of proteins were recorded on d 0, 1, 2, 3, 4, and 5 at 4°C, while reading was taken 12 h interval for 96 h at 25°C. Samples were scanned using a UV-Vis spectrophotometer at specific incubation times from 400 to 700 nm using a Shimadzu spectrophotometer. Since all 3 proteins differ in their oxidation–reduction peaks, the ratio of oxidation to reduction was calculated to compare oxidation. The experiment was replicated 3 times and the data were analyzed using the Mixed Procedure of SAS (SAS Inst. Inc., Cary, NC).

Results

At both temperatures, there were differences ($P < 0.05$) in oxidation properties between hemoglobin, myoglobin, and cytochrome *c*. Myoglobin had greater oxidation, followed by hemoglobin and cytochrome *c* (myoglobin > hemoglobin > cytochrome *c*; $P < 0.05$). Cytochrome *c* was very stable to oxidation compared with other 2 proteins.

Conclusion

The results suggest that redox stability of myoglobin, hemoglobin, and cytochrome *c* are different. Future research determining the inter-relationship between protein oxidation will help to understand beef discoloration.

