**Project Title:** Biochemical and Physical Properties Associated with Meat Color of Beef Muscles Targeted for Future Market Penetration

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## Background

Previous research has shown that meat color is a significant factor in consumers' beef buying decisions. The pigment responsible for the bright red color is oxymyoglobin. Meat changes color depending on how the muscle interacts with oxygen. When oxymyoglobin becomes oxidized, oxygen can no longer bind to the pigment and the muscle turns brown. Different muscles can have a variety of different biochemical and physical properties that affect their ability to produce and maintain a desirable bright red color.

The beef industry has recently introduced new ways to fabricate muscles from the chuck and the round to create products that are more marketable as steaks. New approaches to stabilizing fresh beef color may be important in introducing muscles that have not traditionally been marketed at the retail level as steaks. Modified atmosphere packaging (MAP) that incorporates low levels of carbon monoxide (< 1 percent) is one method that is known to effectively bind myoglobin to form a more stable, bright red color.

The objectives of this study were: 1) determine the differences in muscle oxygen penetration, oxygen consumption ability and reducing ability among 10 different muscles, 2) establish the color display shelf life of the 10 target muscles, and 3) determine the ability of a modified atmosphere package containing carbon monoxide to extend the refrigerated color display shelf life of 10 muscles from the beef carcass.

## Methodology

Ten muscles (*adductor, complexus, gracilis, pectineus, rhomboideus, sartorius,* superficial *pectoral, serratus ventralis, vastus intermedius and vastus lateralis*) were obtained from six carcasses processed at a state-inspected harvest facility. Muscles were vacuum packaged, aged for seven days and then fabricated into steaks. The steaks were measured for pH, muscle oxygen penetration, oxygen consumption ability, anaerobic reducing ability and display shelf life.

## Findings

The ultimate pH of the muscles ranged from 5.50 to 5.79 and there was a significant difference in pH among the muscles. The *vastus intermedius* had the highest pH value, while the *rhomboideus* had the lowest. Past research has indicated if a pH falls within a range of 5.68 ± 0.12, that there is limited influence on metmyoglobin formation and display color stability of beef muscles.

The average depth of oxygen penetration over the period of 24 hours was different among muscles, however there was no significant interaction. There were differences in oxygen consumption ability among the muscles. Differences may have been attributed to



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mitochondrial density, enzyme activity and nicotinamide adenine dinucleotide (NAD) content of the muscles. The lower oxygen consumption ability may contribute to maintaining the bright red color longer. If lower oxygen consumption were to occur at lower partial pressures of oxygen, this would favor metmyoglobin formation. Conversely, a higher oxygen consumption ability would suggest those muscles may outperform the other muscles if merchandized in a vacuum package by producing a more stable color (deoxymyoglobin). The depth of oxygen penetration and oxygen consumption ability showed similar patterns for all the muscles evaluated. Higher oxygen penetration was associated with lower oxygen consumption ability.

Anaerobic reducing ability was significantly influenced by the muscle evaluated. The superficial *pectoral* had the highest mean $a^*$ color value, which indicated an ability to withstand the oxidizing effect of lower concentrations of oxygen. These results were similar to past research that demonstrated that meat color stability and oxidation-reduction potential of myoglobin were highly related to the muscle type.

There were differences in color among the muscles as it related to display shelf life. The *pectineus* was the lightest in color over the course of the study and the *gracilis* was the darkest. The superficial *pectoral* tended to be the most red. The *sartorius* and the *gracilis* were the least yellow. While there were differences in color, the chroma $C^*$ reading means were all above 16 suggesting that they were acceptable in color when pooled over the seven-day storage period.

Not all muscles responded the same to the packaging treatment. Carbon monoxide packaging produced lighter steaks from the *complexus*, *gracilis, rhomboideus, sartorius, serratus ventralis*, and *vastus intermedius* than when packaged with polyvinyl chloride (PVC).

## Implications

While there were some differences in the various physical and biochemical properties of the ten muscles examined in this study, all of the muscles had an adequate ability to allow sufficient oxygen penetration. Some muscles were better at handling exposure to oxidizing conditions than others, so appropriate packaging and storage will aid in their merchandizing value. The use of carbon monoxide packaging of meat has been increasing, but it is important to realize that it may not be beneficial for all of the muscles tested in this study.



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