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Lower oxygen or addition of antioxidants; High-oxygen MAP system diminishes meat quality attributes through oxidation

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Abstract

Demand for central packaging of case-ready meats is greatly increasing and is driving the use of modified atmosphere packaging (MAP) systems with high oxygen incorporation instead of the traditional polyvinyl chloride (PVC) overwrap packaging system. Despite the fact that the initial appearance of fresh meat in high-oxygen modified atmosphere packaging (HiOx-MAP) appeals to consumers, the oxidative environment it creates has some detrimental effects on meat quality during storage and display time. One solution could be minimising oxidation of meat by incorporating antioxidant to fresh meat in HiOx-MAP.

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ABSTRACT:

Demand for central packaging of case-ready meats is greatly increasing and is driving the use of modified atmosphere packaging (MAP) systems with high oxygen incorporation instead of the traditional polyvinyl chloride (PVC) overwrap packaging system. Despite the fact that the initial appearance of fresh meat in high-oxygen modified atmosphere packaging (HiOx-MAP) appeals to consumers, the oxidative environment it creates has some detrimental effects on meat quality during storage and display time. One solution could be minimising oxidation of meat by incorporating antioxidant to fresh meat in HiOx-MAP.

FULL TEXT:

By Yuan Brad Kim, Elisabeth Huff-Lonergan and Steven M. Lonergan

The MAP systems are commonly used to rapidly "modify" or alter the atmosphere within meat packages to enhance colour and/or shelf life of retail meat products. MAP packaging uses a combination of specific gases (O₂, CO₂, CO, N₂). One of the most successful and widely used modified atmosphere systems is one that uses 80% oxygen (O₂) and 20% carbon dioxide (CO₂). This high oxygen system allows more oxygen to penetrate into meat, consequently forming a higher percentage of oxymyoglobin and a brighter cherry red meat colour. The CO₂ in the package aids in preventing microbial growth and therefore, the discolouration associated with high microbial counts. Thus both the O₂ and CO₂ are important in this system to maintain desirable colour in beef. However, high oxygen levels are likely to increase the incidence of oxidative changes in the meat, thus negatively affecting meat quality characteristics such as off-flavour, discolouration, and reduced tenderness.

Further, high oxygen levels may cause more quality problems for some beef round muscles, many of which traditionally been underutilised because of commonly noted tenderness and discolouration defects. A recent study (Kim et al., 2010) conducted by the Iowa State University Meat Science and Muscle Biology group and funded by the Iowa Beef Industry Council revealed chemical and biochemical alterations of postmortem muscles under HiOx-MAP packaging conditions, and the subsequent detrimental effects of the HiOx-MAP system on fresh beef quality attributes. In the study, ten

market weight beef cattle (A-maturity) were slaughtered at the Iowa State University Meat Laboratory. The longissimus lumborum (LL; control muscle), semimembranosus (SM) and adductor (AD) muscles were removed from each beef carcass at 24 hours after slaughter. Steaks (2.54cm thick) were cut from each muscle and randomly assigned to either HiOx-MAP (80% O₂, 20% CO₂) or VAC for packaging. Steaks were displayed for 9 days at 1°C under 2150 lux of fluorescent light. Surface colour (Hunter), pH, thiobarbituric acid reactive substance (TBARS) values, star probe and sensory analysis were measured on steaks at the beginning and at the end of display to determine effect of different packaging systems (HiOx-MAP and VAC) on colour stability, lipid oxidation and sensory attributes of beef round cuts.

More discolouration

in HiOx-MAP

The study revealed that surface redness values (based on a* values) of beef steaks packaged in HiOx-MAP rapidly decreased after 9 d of display, whereas steaks packaged in VAC had no significant change in redness during display (Tab.). SM and AD had greater decrease in surface redness than LL indicating that these round muscles might be more susceptible to myoglobin oxidation. Several studies determined that the HiOx-MAP system created a favourable bright cherry red colour of meat for initial- and mid-display period, but much faster discolouration occurred afterwards compared to other low oxygen or oxygen free packaging systems (Grobbel et al., 2008; Jayasingh et al., 2002; John et al., 2005; Sørheim et al., 1999).

Lipid oxidation and off-flavour in HiOx-MAP

Based on TBARS values, HiOx-MAP packaged beef steaks had an increase in lipid oxidation during display (Tab.). When comparing specific muscles, AD and SM in HiOx-MAP had greater increase in lipid oxidation during display than LL suggesting that these beef round muscles were more susceptible to oxidation than LL. In contrast, the steaks packaged in VAC did not develop significant lipid oxidation during display time. Further, HiOx-MAP packaged beef steaks had an increase in off-flavour development based on sensory evaluation (Fig.), which was probably due to the elevated lipid oxidation. Lipid oxidation, which resulted in the production of (oxy- and lipid-) free radicals, is closely coupled with pigment oxidation, since lipid oxidation is a promoter of myoglobin oxidation (Lin and Hultin, 1977). These results suggest that HiOx-MAP can create more oxidative conditions, which negatively affects myoglobin and lipid oxidation stability, and consequently causes decreased meat colour and flavour desirability.

Less tender meat

in HiOx-MAP

HiOx-MAP packaged beef steaks had significantly lower tenderness and juiciness scores compared to steaks in VAC (Fig.). This effect was even more pronounced in the strip steaks (longissimus lumborum). Instrumental evaluation (star probe) confirmed the sensory tenderness evaluation. The effect of packaging appears to be linked to modifications in the major myofibrillar protein, myosin. Specifically, it appears that aggregation of myosin heavy chain and perhaps other proteins results in a less tender and juicy product. Myosin has been reported to susceptible to oxidation resulting in intermolecular cross-linking and aggregation of the protein (Decker et al., 1993). Therefore, the oxidative conditions created in the HiOx-MAP system resulted in myoglobin and lipid oxidation, and protein polymerisation, subsequently deteriorating meat quality such as colour, flavour and tenderness during storage and display time.

Summary and implications

Beef steaks stored in high-oxygen modified atmosphere packaging (HiOx-MAP) had more discolouration, lipid oxidation and lower tenderness, juiciness and flavour during 9 days display compared to the steaks packaged in vacuum (VAC). Therefore, MAP systems with **lower oxygen** mixture or incorporation of antioxidants through injection enhancement to meat in HiOx-MAP are recommended to minimise oxidation-induced quality deteriorations of beef round muscles.

References

1. Decker, E.A., Y.L. Xiong, J.T. Calvert, A.D. Crum and S.P. Blanchard (1993): Chemical, physical, and functional properties of oxidized turkey white muscle myofibrillar proteins. *J. Agric. and Food Chemistry* 41, 186-189. - 2. Grobbel, J.P., M.E. Dikeman, M.C. Hunt and G.A. Milliken (2008): Effects of packaging atmospheres on beef instrumental tenderness, fresh color stability, and internal cooked color. *J. Anim. Sci.* 1191-1199. - 3. Jayasingh, P., D.P. Cornforth, C.P. Brennand, C.E. Carpenter and D.R. Whittier (2002): Sensory evaluation of ground beef stored in high-oxygen modified atmosphere packaging. *J. Food Science* 67, 3493-3496. - 4. John, L., D.P. Cornforth, C.E. Carpenter, O. Sorheim, B.C. Pettee and D.R. Whittier (2005): Color and thiobarbituric acid values of cooked top sirloin steaks packaged in modified atmospheres of 80% oxygen, or 0.4% carbon monoxide, or vacuum. *Meat Science* 69 441-449. - 5. Kim, Y.H., E. Huff-Lonergan, J.G. Sebranek and S.M. Lonergan (2010): High oxygen modified atmosphere packaging system negatively affects beef quality characteristics by inducing lipid and myoglobin oxidation and protein polymerization. *Meat Science*, submitted for publication. - 6. Lin, T.S. and H.O. Hultin (1977): Oxidation of myoglobin in vitro mediated by lipid oxidation in microsomal fractions of muscle. *J. Food Science* 42, 136-140. - 7. Sørheim, O., H. Nissen and T. Nesbakken (1999): The storage life of beef and pork packaged in an atmosphere with low carbon monoxide and high carbon dioxide. *Meat Science* 52, 157-164.

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Fig.: Sensory attributes of beef steaks packaged in either HiOx-MAP or VAC, and displayed for 9 days at 1°C. Quality loss with HiOx - Tab.: Percent change (Delta %) of a* values (surface redness) and TBARS values (lipid oxidation) during 9 d display at 1 °C under 2150 lux of fluorescent light

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