

Research & Development

## **Modified atmosphere packaging influences premature browning in beef *Longissimus lumborum* steaks**

By S.P. Suman, R.A. Mancini, R. Ramanathan and M.R. Konda

*Keywords:* Premature browning | Cooked colour | Colour-stable beef muscle | MAP | *Longissimus lumborum*

### **References**

1. AMSA (1991): Guidelines for meat color evaluation. American Meat Science Association. Chicago, IL, USA.
2. BIGNER-GEORGE, M. E. and B.W. BERRY (2000): Thawing prior to cooking affects sensory, shear force, and cooking properties of beef patties. *Journal of Food Science* 65, 2–8.
3. CLAUS, J., S. MOHANAN and R. RUSSELL (2005): Biochemical and physical properties of ten different beef muscles in relation to meat color. In Proceedings of 51st International Congress of Meat Science and Technology, August 2005, Baltimore, MD, USA, pp. 389–395.
4. EILERT, S.J. (2005): New packaging technologies for the 21st century. *Meat Science* 71, 122–127.
5. FDA (2004): Agency response letter. GRAS notice no. GRN 000143. Available from <http://www.cfsan.fda.gov/~rdb/opa-g143.html>.
6. HUNT, M.C. and H.B. HEDRICK (1977): Profile of fiber types and related properties of five bovine muscles. *Journal of Food Science* 42, 513–517.
7. HUNT, M.C., O. SORHEIM and E. SLINDE (1999): Color and heat denaturation of myoglobin forms in ground beef. *Journal of Food Science* 64, 847–851.
8. JOHN, L., D.P. CORNFORTH, C.E. CARPENTER, O. SORHEIM, B.C. PETTEE and D.R. WHITTIER (2004): Comparison of color and thiobarbituric acid values of cooked hamburger patties after storage of fresh beef chubs in modified atmospheres. *Journal of Food Science* 69, 608–614.
9. 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.
10. KING, N.J. and R. WHYTE (2007): Does it look cooked? A review of factors that influence cooked meat color. *Journal of Food Science* 71, 31–40.
11. MACHLIK, S.M. (1965): The effect of heat on bovine myoglobin derivatives in model systems and in beef *semitendinosus* muscle. Ph.D. Dissertation, Purdue University.
12. MANCINI, R.A., S.P. SUMAN, M.K.R. KONDA and R. RAMANATHAN (2009): Effect of carbon monoxide packaging and lactate enhancement on the color stability of beef steaks stored at 1 °C for 9 days. *Meat Science* 81, 71–76.
13. MCKENNA, D.R., P.D. MIES, B.E. BAIRD, K.D. PFEIFFER, J.W. ELLEBRACHT and J.W. SAVELL (2005): Biochemical and physical factors affecting discoloration characteristics of 19 bovine muscles. *Meat Science* 70, 665–682.

14. NAMP (2002): The meat buyers guide. North American Meat Processors Association, Reston, VA, USA.
15. O'KEEFFE, M. and D.E. HOOD (1982): Biochemical factors influencing metmyoglobin formation on beef from muscles of differing colour stability. *Meat Science* 7, 209–228.
16. SAS (2007): SAS User's Guide version 9.3. SAS Institute Inc., Cary, NC, USA.
17. SEPE, H.A., C. FAUSTMAN, S. LEE, J. TANG, S.P. SUMAN and K.S. VENKITANARAYANAN (2005): Effects of reducing agents on premature browning in ground beef. *Food Chemistry* 93, 571–576.
18. SEYFERT, M., M.C. HUNT, R.A. MANCINI, D.H. KROPF and S.L. STRODA (2004a): Internal premature browning in cooked steaks from enhanced beef round muscles packaged in high-oxygen and ultra-low oxygen modified atmospheres. *Journal of Food Science* 69, 142–146.
19. SEYFERT, M., R.A. MANCINI and M.C. HUNT (2004b): Internal premature browning in cooked ground beef patties from high-oxygen modified-atmosphere packaging. *Journal of Food Science* 69, 721–725.
20. SEYFERT, M., R.A. MANCINI, M.C. HUNT, J. TANG and C. FAUSTMAN (2007): Influence of carbon monoxide in package atmospheres containing oxygen on colour, reducing activity, and oxygen consumption of five bovine muscles. *Meat Science* 45, 432–442.
21. SEYFERT, M., R.A. MANCINI, M.C. HUNT, J. TANG, C. FAUSTMAN and M. GARCIA (2006): Color stability, reducing activity, and cytochrome c oxidase activity of five bovine muscles. *J. Agricultural and Food Chemistry* 54, 8919–8925.
22. SUMAN, S.P., C. FAUSTMAN, S. LEE, J. TANG, H.A. SEPE, P. VASUDEVAN, T. ANNAMALAI, M. MANOJKUMAR, P. MAREK, M. DECESARE and K.S. VENKITANARAYANAN (2004): Effect of muscle source on premature browning in ground beef. *Meat Science* 68, 457–461.
23. SUMAN, S.P., C. FAUSTMAN, S. LEE, J. TANG, H.A. SEPE, P. VASUDEVAN, T. ANNAMALAI, M. MANOJKUMAR, P. MAREK, M. DECESARE and K.S. VENKITANARAYANAN (2005): Effect of erythorbate, storage and high-oxygen packaging on premature browning in ground beef. *Meat Science* 69, 363–369.
24. SUMAN, S.P., R.A. MANCINI, R. RAMANATHAN and M.R. KONDA (2009): Effect of lactate enhancement, modified atmosphere packaging, and muscle source on the internal cooked colour of beef steaks. *Meat Science* 81, 664–670.
25. USDA (1997): USDA advises consumers to use a meat thermometer when cooking hamburger. FSIS News and Information Bulletin. FSIS, USDA, Washington, DC, USA.
26. WARREN, K.E., M.C. HUNT and D.H. KROPF (1996): Myoglobin oxidative state affects internal cooked color development in ground beef patties. *Journal of Food Science* 61, 513–515, p. 519.

### **Authors' addresses**

S.P. Suman (corresponding author), Department of Animal and Food Sciences, University of Kentucky, Lexington, KY 40546, USA, [spsuma2@email.uky.edu](mailto:spsuma2@email.uky.edu);  
 R.A. Mancini, R. Ramanathan and M.R. Konda, Department of Animal Science, University of Connecticut, Storrs, CT 06269, USA