BEEF TRAITS WITH DIFFERING FABRICATION TIMES AND GASES IN MODIFIED ATMOSPHERE PACKAGING

McMILLIN K.W., HUANG N.Y., HO C.P. and SMITH B.S.

Louisiana State University Agricultural Center, Department of Animal Science, Louisiana, United States.

S-IIA.10

SUMMARY

Steaks (M. longissimus lumborum) fabricated at ½, 48, and 96 hr postmortem were packaged in vacuum packaging (VP) or 80% N_2/20% CO_2 modified atmosphere packaging (MAP). At 16 days postmortem, steaks in VP were removed and overwrapped in air-permeable film and MAP atmospheres were exchanged for 80% O_2/20% CO_2 and 60% O_2/40% CO_2. Oxidative stability was maintained with increased O_2 in MAP. Psychrotrophic counts increased with increased postmortem time.

Redness was increased with 48 hr fabrication while lightness, pH, and psychrotrophic growth were intermediate to ½ or 96 hr fabrication. Color development increased with increased display time but oxidative stability was decreased through 24 hr.

INTRODUCTION

Fresh meat acceptability is limited by accumulation of metmyoglobin (MetMb) on the surface (MacDougall, 1982) so optimization of meat color involves delay of pigment oxidation and reduction of MetMb (Giddings, 1977). Color stability is influenced by light, temperature, gas composition, and reducing conditions (Kropf, 1993). Fabrication time postmortem also influences color stability (Madhavi and Carpenter, 1993). Modified atmosphere packaging (MAP) has not been widely accepted by consumers if inert gases which promote deoxymyoglobin are used and has a short distribution time if oxygen to promote oxymyoglobin is included. Active exchange of atmospheres in MAP offers extended distribution and retail shelf life of fresh meat when compared with conventional air-permeable overwrap packaging or VP (Huang et al., 1993).

The current study was conducted to determine the influence of postmortem fabrication time and differing MAP gas combinations on shelf life of beef.

MATERIALS AND METHODS

Crossbred Brahman beef steers were slaughtered at the Louisiana State University Agricultural Center Meat Laboratory after 175 days on feed (68.5% TDN, 10.5% CP). Loin subprimals were removed from carcasses at ½, 48 or 96 hr postmortem and steaks (M. longissimus lumborum) of 1.9 cm thickness were cut, packaged in vacuum pouches (VP) (O_2 transmission of 10 cc/m^2/24 hr) or MAP barrier plastic trays (O_2 transmission of 4 cc/m^2/24 hr) containing 80% N_2: 20% CO_2 sealed with lidding film (O2 transmission of 9 cc/m^2/24 hr), and stored in fiberboard boxes. After 16 days at 2°C, steaks in VP were removed and overwrapped with polyvinyl chloride (PVC) (Borden Resinite, O2 transmission of cc/m^2/24 hr) and atmospheres in MAP were exchanged (Windjammer, Pakor, Inc., Livingston, TX) for 80% O_2: 20% CO_2 or 60% O_2 : 40% CO_2. Packages were displayed at 4°C under 550 lux cool white fluorescent lighting.

Packages of steaks were analyzed initially, at 8 and 16 days storage, and at 2, 12 and 24 hr display. pH at the steak surface was measured with a probe electrode (Extech Instruments Corp., Waltham, MA) at 3 locations. The O_2 and CO_2 in the MAP headspace were measured using a Food Package Analyzer (Series 1400, Servomex, Sussex, England). Objective color analyses of L (lightness), a (red/green), and b (yellow/blue) values (LABSCAN-2 0/45, Hunter Associate Laboratory, Inc., Reston, VA) were averaged on each steak by rotating 90° between each of 3

readings per sample. Weight retention was calculated as sample weight/initial weight x 100%.

Psychrotrophic plate counts (PPC) were determined as $\log_{10}$ colony forming units (CFU) per g by plate count procedures using pour-plates (APHA, 1976) with plate count agar and incubation at 6°C for 8 to 10 days. Oxidative stability was determined with TBARS values using a distillation method as outlined by Tarladgis et al. (1960). Metmyoglobin reducing activity (MRA) was measured by the method of Stewart et al. (1965). Metmyoglobin reducing activity was expressed by the differences in K/S 572:K/S 525 after 30 min incubation at 30°C.

The statistical model was a split-plot design with main effect of animal and sub-plots of postmortem fabrication time, packaging treatment, and display time. Data was analyzed by analysis of variance (ANOVA) using the general linear model (GLM) procedure of the Statistical Analysis System (SAS, 1985). Treatment means were separated by the Least-Square Means procedures at $P \leq 0.05$.

RESULTS AND DISCUSSION

Residual O_2 in MAP after initial packaging was less than 0.5% and was unchanged through 16 days of storage. After atmosphere exchange, the O_2 and CO_2 contents of packages were different ($P<0.05$) with differing gas mixtures and with postmortem time of steak fabrication (Figure 1). The relative efficiency of gas exchange was 70 to 78%.

Postmortem fabrication time influenced ($P<0.05$) beef properties except for lipid stability (Table 1). Increased postmortem time decreased pH and weight retention and increased HunterLab L and b values and psychrotrophic microorganism growth. Griffin et al. (1982) reported increased discoloration in steaks with increased time of postmortem cutting. Madhavi and Carpenter (1993) indicated that steaks fabricated at 4 or 7 days had improved color compared to 2, 14 and 21 day fabrication.

The 80% O_2: 20% CO_2 MAP system increased ($P<0.05$) L values and decreased ($P<0.05$) psychrotrophic growth compared with the VP-PVC system. Georgala and Davidson (1970) reported increased color purity with increased levels of O_2 in MAP. Weight retention of steaks in MAP was increased ($P<0.05$) compared with VP-PVC. MRA was not affected by packaging type. Differences were observed from samples from different animals and activity was highest with ½ postmortem time. Increased display time increased ($P<0.05$) HunterLab L, a, and b values, but decreased oxidative stability. Display time did not influence pH or weight retention.

CONCLUSION

The postmortem time of steak fabrication and type of packaging influenced color stability, psychrotrophic microorganism growth and weight retention. Fabrication at 48 hr provided increased redness and intermediate L value, pH, and psychrotrophic growth compared with ½ or 96 hr fabrication. Color was lighter and redder with increased time of display, but oxidative stability was decreased through 24 hr.

REFERENCES

APHA., (1976). Compendium of Methods for the Microbiological Examination of Foods. Am. Publ. Health Assn., Washington, D.C.

Giddings, G., (1977). The basis of color in muscle foods. J. Food Sci., 42:288-294.

Georgala, D.L. and Davidson, C.M., (1970). Food package. British patent 1,199,998.

Griffin, D.L., Savell, J.W., Smith, G.C., Vanderzant, C., Terrell, R.N., Lind, K.D. and Galloway, D.E., (1982). Centralized packaging of beef loin steaks with different oxygen-barrier films: Physical and sensory characteristics. J. Food Sci., 47:1059-1069.

Huang, N.Y., McMillin, K.W., Ho, C.P., and Smith, B.S., (1993). Retail beef in dynamic gas exchange modified atmosphere packaging with different distribution storage temperatures. Intl. Congr. Meat Sci. & Technol., 39:S8P7.

Kropf, D.H., (1993). Colour stability. Meat Focus Intl., 2(6):269-275.
MacDougall, D.B., (1982). Changes in the colour and opacity of meat. Food Chem. 9:75-88.
Madhavi, D.L. and Carpenter, C.E., (1993). Aging and processing affect color, metmyoglobin reductase and oxygen consumption of beef muscles. J. Food. Sci. 58: 939-942, 947.
SAS., (1985). SAS User's Guide: Statistics. 5th ed. SAS Institute, Inc.; Cary, NC.
Stewart, M.R., Hutchins, B.K., Zipser, M.W. and Watts, B.M., (1965).
Enzymatic reduction of metmyoglobin by ground beef. J. Food Sci., 30:487-491.
Tarladgis, B.G., Watts, B.M. and Younathan, M.T., (1960). A distillation method for the quantitative determination of malonaldehyde in rancid foods. J. Am. Oil Chem. Soc., 37:44-48.