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ROSEMARY OLEORESIN EXTENDS THE SHELF LIFE OF GROUND BEEF STORED AT ABUSIVE TEMPERATURES

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Introduction

While pathogens are of large concern to the meat industry, other factors including cost and quality are important as well. Spoilage characteristics that are typically associated with meats include color, odor, and texture changes. These characteristics can be affected by many different factors including: storage temperature, atmospheric oxygen, light, meat constituents, microorganisms, and endogenous enzymes (Lambert et al., 1991). Ground beef is affected not only by microbial growth, but also by chemical reactions such as lipid oxidation. Rosemary oleoresin has been found to have comparable antioxidant properties to that of a BHT/BHA/citric acid mix (Barbut et al., 1985). However, numerous health benefits associated with lactic acid bacteria (LAB) have been studied, including their role as biopreservatives in foods. They are found in many foods, because of their ability to grow under a wide variety of environmental conditions. The LAB also play an important role in food fermentations, having a preservative effect on the product (Stiles, 1996). Additionally, LAB have GRAS (generally recognized as safe) status (Brashears et al., 2005).

Objectives

The objective of this study was to determine color stability, odor characteristics, and oxidative rancidity susceptibility when rosemary oleoresin and LAB were added to ground beef packaged in modified atmosphere packaging and displayed at refrigeration and abusive temperatures.

Methodology

The spoilage characteristics of ground beef were evaluated by inoculating ground beef with a combination of LAB or sterile distilled water (control). Samples were stored in retail display cases with a light intensity of approximately 1900 lux and collected at the following times during display: 0, 24, 48, 72 and 84 h for patties displayed at 0°C, and 0, 12, 24, and 36 h for those displayed at 10°C. Coarse-ground beef was obtained from a commercial beef-packing facility. A cocktail of 4 strains of lactic acid bacteria consisting of *Lactobacillus acidophilus* NP 51, *Lactobacillus crispatus* NP 35, *Pediococcus* *acidilactici*, and *Lactococcus lactic* spp. *Lactis* was provided by Culture Systems, Inc. (Mishawaka, IN) for use in this study at an inoculation level of 10^9 cfu/g meat.

For each replication (n = 3), 34.85 kg of ground beef was divided into four, 8.71 kg treatments: (1) control; (2) rosemary oleoresin; (3) LAB only; and (4) LAB + rosemary oleoresin. For LAB treatment groups, 17.42 kg ground beef was mixed thoroughly for 1 min, then 250 mL of a 10^9 cfu LAB/g solution suspended in sterile distilled water was added to the ground beef, the mixer direction was reversed, and the ground beef was mixed for 1 min. Using a 0.32 cm fine grind plate, the meat was passed through a three-phase meat grinder. Patties weighing 145.2 g were formed using a patty machine. The remaining 17.42 kg of ground beef was processed as above, except 250 mL of sterile distilled water only was added to serve as the control. Herbalox Type HT – rosemary oleoresin (Kalsec, Inc; Kalamazoo, MI) was added at a level of 0.01% (w/w; 1000 ppm) to the ground beef. Equipment was cleaned thoroughly between treatments and rinsed with 180°C water.

Once the patties were formed, 2 patties were placed in a plastic lidded tray. A gas flush, tray sealing machine was used to seal the film onto the trays. Packages were flushed with a targeted of 80% O_2 and 20% CO_2. Packages in each treatment group were randomly identified and assigned to either a 0°C or 10°C coffin-style retail display case for display. The display cases were kept under flourescent lighting at an intensity of approximately 1900 lux. Headspace was analyzed on random packages during processing. A total of 40 packages per replication were prepared (n = 10 packages per treatment group).

Trained and consumer panelists were utilized to detect differences in color and odor of the treated ground beef. Trained panelists scored the patties for ground meat color (1 = very bright red; 5 = very dark red or brown), as well as surface discoloration (1 = no discoloration; 2 = slight, 1–10%; 3 = small, 11–20%; 4 = moderate, 21–60%; 5 = severe discoloration, 61–100%) as outlined by the AMSA color guidelines (AMSA, 1991). Untrained panelists served as the consumer panel and were asked to determine if the meat had good color (1 = very strongly agree; 7 = very strongly disagree) and how likely they were to purchase (1 = definitely would purchase; 5 = definitely would not purchase) the package (AMSA, 1991).

Odor panels were also conducted on packages removed from the cases at each sampling interval. The packages were opened in a random order and the panelists were allowed to smell the patties, using verbal descriptors adapted from Payne et al., 2002. Briefly, panelists were asked to determine if an immediate off-odor was present (1 = no off-odor; 5 = extreme off-odor) and to characterize the off odor if present (1 = rancid; 2 = arid; 3 = sweet; 4 = sour; 5 = acid; and 6 = putrid). Consumer panelists were asked if the meat in the package smelled fresh (1 = very strongly agree; 7 = very strongly disagree) and how likely they were to consume the meat (1 = definitely would consume; 5 = definitely would not consume) based upon the odor.

Commission Internationale de I'Eclairage (CIE) L* (luminance or muscle lightness), a* (redness or muscle redness), and b* (yellowness or muscle yellowness) were taken on one patty from each package opened at the sampling interval. Each patty was evaluated using the MiniScan XE Plus (Hunter Association Laboratory, Incorporated; Reston, VA). Two readings from randomly selected locations were taken from each patty and averaged to determine the L*, a*, and b* values of the patty.

TBA assays were performed to estimate oxidative rancidity on the remaining one-half of the patties in the Texas Tech University Animal and Food Sciences Nutrition Laboratory according to modified procedures outlined by Buege and Aust (1978).

Results & Discussion

Temperature Display at 0°C

Trained panelist responses for lean color and surface percentage brown discoloration did not significantly differ between treatments for ground beef patties displayed at 0°C. Also, trained panelist responses for immediate off-odors of ground beef patties did not significantly differ between treatments. Trained panelists also characterized off-odors at each sampling interval. At 0 h, 100% of the patties for each treatment were characterized as having no off-odor. Later in the display period, a large portion of the LAB-inoculated ground beef patties containing resin were characterized as not having an off-odor present, compared to patties without resin where a majority of the patties were either characterized as rancid or sour.

No significant differences were found between treatments for consumer responses for lean color of ground beef and purchase intent based upon ground beef patty color. Consumer panelist responses to questions concerning the freshness of odor of the ground beef as well as the consumer's likelihood to consume the product did not significantly differ between treatments. Hunter L*, a*, and b* values did not significantly differ between treatment groups. These results agree with the trained and consumer panelists responses.

Significant ($P < 0.05$) differences did occur between treatments for TBA values. Treatment groups with resin had significantly ($P < 0.05$) lower values than treatment groups without resin, despite the addition of lactic acid bacteria. Therefore, lipid oxidation would be slowed with the addition of rosemary to ground beef.

Temperature Display at 10°C

Trained panelists analyzed lean color and no significant differences were found in responses for this trait between treatments. No significant differences were found between treatments for panelist responses for percent discoloration. At time 0 h, panelist scores for immediate off-odor were not significantly different for treatments applied to the ground beef. After 24 h of display, uninoculated and inoculated ground beef patties with added rosemary oleoresin had significantly ($P < 0.05$) lower scores than the uninoculated and LAB-inoculated ground beef without added resin. This trend continued throughout the remainder of the display period. Rosemary oleoresin slows lipid oxidation, which produces unpleasant odors. Therefore, the treatment groups with added oleoresin would be expected to have lower immediate off-odor scores as compared to the treatment groups without added oleoresin. Also, trained panelists were asked to characterize the off-odor. At time 0 h, 100% of the uninoculated ground beef patties with or without resin were characterized as having no off-odor. As display progressed, the percent of uninoculated ground beef patties without resin characterized as rancid and sour increased. Also, a larger percentage of patties with added resin had no off-odor. LAB-inoculated ground beef patties with and without added rosemary oleoresin were classified as having no off-odor at time 0 h. As compared to the LAB-inoculated ground beef patties without added rosemary oleoresin, a larger percentage of the LAB-inoculated ground beef patties with rosemary oleoresin were characterized as not having an off-odor at the end of the display period. This indicated that the addition of the oleoresin slowed the on-set of undesirable odors through the inhibition of lipid oxidation.

Significant ($P < 0.05$) differences were found between treatments in consumer panelist response scores for lean ground beef color. LAB-inoculated ground beef without added oleoresin had significantly ($P < 0.05$) higher scores than the treatment groups with added oleoresin, indicating a darker, less desirable color. Based on lean ground beef color, the consumers indicated how likely they were to purchase the package of ground beef if it had been available in retail stores. The consumer scores were not significantly different between treatments. Significant ($P < 0.05$) differences between treatments were also found in consumer panelists responses for odor freshness. The treatment groups with added oleoresin had significantly ($P < 0.05$) fresher odor scores than the uninoculated ground beef patties without added resin. No significant differences were found between treatments in response scores for the likelihood of consumption based on the odor of the meat.

Hunter L*, a*, and b* values were taken at each sampling interval. No significant differences were found in L* values for any treatment group displayed at abusive temperatures. The treatment groups with added oleoresin had significantly ($P < 0.05$) higher a* values than the uninoculated ground beef patties without added resin. The uninoculated ground beef patties without resin had significantly ($P < 0.05$) lower b* scores than the treatment groups with added resin. By adding rosemary oleoresin, the deterioration of ground beef color was slowed.

Initially, TBA values did not significantly differ between treatments. After 12 h of display, the treatment groups with added oleoresin had significantly ($P < 0.05$) lower TBA values than the treatment groups without resin. The treatment groups without added oleoresin had significantly ($P < 0.05$) higher TBA values than those treatment groups with added resin after 24 and 36 h of display. These results indicate that the addition of rosemary oleoresin slowed lipid oxidation as the display period progressed despite the addition of LAB.

Conclusions

The results of this study showed that rosemary oleoresin was effective in extending the shelf life of ground beef patties stored in MAP packaging by decreasing lipid oxidation at both 0 and 10°C. Also, consumer color and odor scores revealed that the addition of resin produced brighter red, longer-lasting fresher beef patties when stored at 10°C, and more desirable odor scores at 0°C as well. However, analysis of both trained and consumer color and odor panels revealed no significant differences between samples with added LAB and those without. Additionally at 0 and 10°C, trained color and odor panels of beef patties containing resin were not significantley differenct compared to those without added resin. At 0 and 10°C, Hunter a* values were significantly higher, and b* values were significantly lower, incicating rosemary oleoresin helped to maintain beef patty color during retail display. TBA assays showed that the addition of rosemary slowed the lipid oxidation process at both 0 and 10°C. This is in agreement with several researchers who also found that lipid oxidation was inhibited by the addition of the natural antioxidant (Sanchez-Escalante et al., 2001; Ho et al., 1995; Barbut et al., 1985). Therefore, this natural antioxidant can maintain color and freshness for extended periods of time, even at abusive temperatures.

References

AMSA. 1991. Guidelines for Meat Color Evaluation. 44th Reciprocal Meat Conference. National Live Stock and Meat Board. Chicago, IL.

Barbut, S., D.B. Josephson, and A.J. Maurer. 1985. Antioxidant properties of rosemary oleoresin in turkey sausage. J. Food Sci. 50:1356–1359,1363.

Brashears, M.M., A. Amezquita, and D. Jaroni. Lactic acid bacteria and their uses in animal feeding to improve food safety. In Food and Nutrition Reviews to be published in Spring 2005.

Buege, J.A. and S.D. Aust. 1978. Microsomal lipid peroxidation. Methods Enzymol. 52:302–310.

Ho, C.P., D.L. Huffman, D.D. Bradford, W.R. Egbert, W.B. Mikel and W.R. Jones. 1995. Storage stability of vacuum packaged frozen pork sausage containing soy protein concentrate, carrageenan or antioxidants. J. Food Sci. 60:257–261.

Lambert, A.D., J.P. Smith, and K.L. Dodds. 1991. Shelf life extension and microbiological safety of fresh meat – a review. Food Microbiol. 8:267–297.

Payne, K.R., J.C. Brooks, J.B. Morgan and F.K. Ray. 2002. The effect of fresh and frozen storage on palatability, oxidative rancidity, and color of modified atmosphere packaged beef steaks. In Animal Science Research Report. Oklahoma State University: Stillwater, OK.

Sanchez-Escalante, A., D. Djenane, G. Torrescano, J.A. Beltran, and P. Roncales. 2001. The effects of ascorbic acid, taurine, carnosine and rosemary powder on colour and lipid stability of beef patties packaged in modified atmosphere. Meat Sci. 58:421–429.

Stiles, M.E. 1996. Biopreservation by lactic acid bacteria. A.v. Leeuwenhoek. 70:331–345.