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Effects of Lipoic Acid Supplementation on Finishing Steer Growth Performance, Carcass Merit, Beef Tenderness, and Beef Retail Display Properties

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Abstract

*Angus cross steers (n = 84; BW = 325 ± 3 kg) were used to evaluate the effects of lipoic acid (**LA**) supplementation on growth performance, carcass merit, beef tenderness, and beef retail display properties. Treatments were control (no LA), 8 mg of LA/kg of BW per d (**LA8**), and 16 mg of LA/kg of BW per d (**LA16**). Lipoic acid was incorporated into an extruded corn flour pellet and top-dressed onto a finishing diet for 125 d. Steers were subsequently delivered to a commercial abattoir for harvest. Carcass data and left-side longissimus sections (6th to 12th rib) were collected from each carcass at 24 h post-mortem. Steaks from each longissimus section were analyzed for Warner-Bratzler shear force (**WBSF**) and color. Final BW of control steers was greater (P<0.01) than that of LA16 steers; final BW of LA8 steers was intermediate between the two. There were no treatment differences in ADG, DMI, or gain to feed ratio (**G:F**). Treatment had no effect on carcass weight, marbling score, longissimus area, kidney-pelvic-heart fat, or USDA yield grade. Subcutaneous fat thickness and the percentage of USDA Yield Grade 4 carcasses tended (P≤0.09) to be greater for LA16 steers than for control steers; LA8 carcasses were intermediate between control and LA16 steers in both categories. Mean WBSF values for steaks aged 21 d were less (P<0.01) for LA16 steers than for control and LA8 steers. Lipoic acid supplementation had negligible effects on subjective color scores of steaks aged from 7 to 21 d. Lipoic acid supplementation appeared to increase external fatness of beef carcasses.*

(Key Words: Beef, Yield Grade, Feed Additive, Tenderness.)

Introduction

Lipoic acid (LA) is considered a universal antioxidant because it 1) can scavenge a wide range of free radicals, 2) directly and indirectly regenerate antioxidants, 3) chelate a wide variety of metals that are associated with increased production of free radicals, and 4) inhibit gene over-expression (Packer et al., 1995). Lipoic acid is both fat- and water-soluble, which promotes rapid passive transport across cellular membranes. In the interior of the cell, the oxidized form of LA, dihydrolipoic acid, regenerates vitamin E, vitamin C, and glutathione peroxidase (Bustamante et al., 1998). These properties may make LA useful for extending the shelf-life of beef products.

Lipoic acid increased glucose uptake by muscle and adipose cells by 50% (Henriksen et al., 1994). This property may make LA useful for enhancing carcass characteristics of finishing cattle. The objectives of this study were to evaluate the effects of supplementing LA to finishing steers on 1) steer growth performance, 2) steer carcass characteristics, 3) longissimus steak tenderness, and 4) longissimus steak retail display properties.

Materials and Methods

The Animal Care and Use Committee of the University of Missouri approved the experimental procedures used in this study. Angus cross steers (n = 84; BW = 326 ± 3 kg) were stra-

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tified by BW and finishing diet and assigned randomly to one of 12 pens (four pens per treatment). Individual pens were randomly assigned to receive supplemental LA (MTC Industries, Long Island, NY) at 0 (control), 8 (LA8), or 16 (LA16) mg of LA/kg of BW/d. Steers were individually weighed and implanted with Revalor IS® (Intervet, Millsboro, DE) before being sorted into their assigned pens. Finishing diets were formulated to achieve an ADG of 1.6 kg/d (NRC, 2000).

Supplemental levels of LA were chosen based on recent publications in human medicine (Packer et al., 1995; Bustamante et al., 1998). Schmidt (2004) demonstrated that dry, powered LA dosed directly into the rumen of steers was followed 30 min later by a spike in serum LA. The greatest serum concentration was observed 1 h after ruminal administration of LA. Dosing steers ruminally with the same amount of LA prilled in paraffin wax was also followed by increased serum LA concentration; however, the peak in serum LA concentration was later and of lesser magnitude compared with unprotected LA. Our LA source was a 50:50 mixture of the compound's R- and S-isomers.

Lipoic acid was incorporated into a corn flour extruded pellet (90% flour) to minimize loss during the feeding process, to mask the strong flavor of LA, and to allow visual monitoring of LA consumption. Control animals received a 100% corn flour pellet. Pellets were top-dressed onto finishing diets immediately following daily feed delivery.

Cattle were weighed at the beginning of the trial and at 28-d intervals thereafter. At the end of each 28-d period, the amount of supplemental LA delivered to each pen was adjusted to ensure that the appropriate dose, relative to steer BW, was being delivered. Bunks were observed daily (0700 and 1500 h) to monitor consumption of feed and LA supplement. Steers were re-implanted with Revalor IS® (Intervet) on d 56 of the trial. On d 126, steers were transported 365 km to a commercial abattoir and harvested under the supervision of the USDA and in compliance with the Humane Slaughter Act of 1978.

A trained observer assigned liver scores based on the system of Brink et al. (1990). Livers with one or two small, encapsulated abscesses (<2.54 cm in diameter) were scored as A-. Livers with 2 to 4 small, encapsulated abscesses (<2.54 cm in diameter) were scored as A. Livers with large, enflamed abscesses (>2.54 cm in diameter) were scored A+. After a 24-h chill (2°C), carcasses were cut at the 12th and 13th rib interface and allowed approximately 15 min to bloom. Carcasses were then graded for yield and quality. A trained evaluator blinded to treatments assigned marbling scores for each carcass according to USDA (1997) standards.

The 6th to 12th rib section from the left longissimus of all carcasses was removed and shipped to the University of Missouri meats laboratory. Upon arrival, each rib was de-boned, trimmed, and cut into 2.54-cm steaks. Steaks were numbered consecutively as they were removed from the rib. Steak 1 was the most anterior steak (closest to the 6th rib), and Steak 10 was the most posterior steak (closest to the 12th rib). Steaks 3 through 5 from each rib were designated for analysis of retail display properties and assigned randomly to be aged for 7, 14, or 21 d prior to display. Steaks 6 through 8 were designated for Warner-Bratzler shear force (WBSF) analysis and assigned randomly to be aged for 7, 14, or 21 d prior to cooking. Each steak was individually vacuum-packaged and maintained at 2°C during the aging process.

After aging, WBSF steaks were cooked for 9 min on a MagiKitch'n® electric belt grill (Blodgett Co., Quakertown, PA) with upper and lower plates set to 118°C. This procedure was designed to achieve an internal endpoint temperature of 70°C (Lawrence et al., 2001). Steaks were cooled at 2°C for 24 h and then allowed to equilibrate to room temperature (approximately 22°C). Six cores (1.27 cm diameter) were removed from each steak parallel to the muscle fiber. Cores were sheared perpendicular to the long axis of the cores (AMSA, 1995). The mean WBSF value for the six cores was reported for each steak.

Because of limited retail display space, three steaks were selected randomly from each pen from among steaks designated for retail display property analysis and that had marbling scores between Small^{80} and Modest^{80} (n = 36). After the appropriate aging period, individual steaks were placed on white Styrofoam trays and wrapped with oxygen-permeable polyvinyl chloride packaging film. Packages were arranged randomly in a commercial retail coffin-type case (Zero Line Inc., North Prairie, WI). The temperature within the retail display case was maintained at 2 to 4°C under continuous cool fluorescent lighting (1300 lx). Steaks within each package were evaluated for subjective color and discoloration once per day at 0800 h for 5 d by a seven-member panel. Color was evaluated on a five-point scale (1 = very bright cherry red, 2 = bright cherry red, 3 = slightly dark red to gray, 4 = moderately grayish tan to brown, and 5 = tan to brown; Lawrence et al., 2003). Discoloration was evaluated on a seven-point scale (1 = 0% discolored, 2 = 1 to 10% discolored, 3 = 11 to 25% discolored, 4 = 26 to 50% discolored, 5 = 51 to 75% discolored, 6 = 76 to 99% discolored, and 7 = 100% discolored; Lawrence et al., 2003).

Performance data were analyzed as a completely random design split-plot in time (Steel and Torrie, 1980). Pen was used as the experimental unit for performance data. A mixed model was used to analyze effects of pen, treatment, weigh period, and treatment × weigh period. Treatment × weigh period was used as the error term to test whole-plot effects. Carcass characteristics were analyzed as a completely random design, using individual carcass as the experimental unit. Warner-Bratzler shear force data