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Original Article

Vitamin and mineral content of value cuts from beef steers fed distiller's grains

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ABSTRACT

Selected vitamin (vitamin E, thiamin, riboflavin, niacin, vitamin B_6, and vitamin B_{12}) and mineral (calcium, phosphorus, magnesium, potassium, sulfur, iron, copper, zinc, manganese, and sodium) concentrations were determined for the value cuts—flat iron steaks (*musculus infraspinatus*) and petite tenders (*musculus teres major*) from cross-bred steers fed finishing rations containing 0% or 40% DM wet distiller's grains plus solubles (WDGS) with and without added daily supplemental vitamin E. The feeding treatment groups were: 0% WDGS with basal vitamin E ($n = 6$), 0% WDGS with supplemental vitamin E (500 IU/steer top-dressed daily) ($n = 7$), 40% WDGS with basal vitamin E ($n = 8$), and 40% WDGS with supplemental vitamin E ($n = 8$). Few differences in micronutrient concentrations were observed in either cut by treatment groups. Feeding steers diets containing 40% WDGS decreased vitamin B_{12} and increased sodium concentrations in flat iron steaks and increased thiamin and decreased manganese concentrations in petite tenders. Significant differences in α-tocopherol concentrations in both cuts were observed by vitamin E grouping. Several significant differences were observed by cut. Uncooked flat iron steaks and petite tenders from these steers are rich sources of vitamin B_{12}, zinc, and sometimes phosphorus, good sources of riboflavin, niacin, vitamin B_6, and iron, and low in sodium.

1. Introduction

The dramatic increase in ethanol production from corn has influenced cattle feeding. Currently many cattle producers are feeding their animals wet distiller's grains plus solubles (WDGS), a by-product of ethanol production from grains. WDGS as part of beef cattle finishing rations have been reported to be efficiently utilized as protein and energy sources (Larson et al., 1993). These byproducts offer the cattle industry an opportunity to reduce feed costs while actually improving growth performance (Corrigan et al., 2009; Klopfenstein et al., 2008). WDGS have a high polyunsaturated fatty acid (PUFA) concentration (de Mello et al., 2008). Requirements for vitamin E, a potent fat-soluble antioxidant, in beef cattle are dependent on the quantities of dietary PUFAs, other antioxidants, S-containing amino acids, and selenium (McDowell, 1989; U.S. National Research Council, 2000). Dietary vitamin E supplementation of beef cattle has been reported to increase the skeletal muscle concentrations of α-tocopherol, though not to the extent that meat cuts from these animals become good sources of the vitamin for humans (Arnold et al., 1992; Liu et al., 1995; Zerby et al., 1999). The feeding of supplemental vitamin E to beef cattle also has been reported to minimize the rancidity problem (Arnold et al., 1992, 1993; Liu et al., 1995; Sanders et al., 1997). The only form of the tocopherols and tocotrienols that has vitamin E activity is α-tocopherol (Institute of Medicine, 2000).

Techniques developed during the past decade make it possible for processors and retailers to fabricate and merchandize certain muscles in the beef carcass to value-added cuts which have desirable sensory properties. These cuts are typically available at less cost than more traditional steaks and thus are a value to consumers. Information is not available as to the vitamin and mineral content of the recently fabricated (North American Meat Processors Association, 2006) beef value cuts flat iron steaks (*musculus infraspinatus*) and petite tenders (*musculus teres major*) nor whether the micronutrient (vitamin and mineral) composition is influenced by feeding beef steers WDGS with or without supplemental vitamin E. The objective of this study was to determine if WDGS from corn and/or supplemental vitamin E fed as components of a finishing ration to beef steers influenced the selected micronutrient concentrations of flat iron steaks and petite tenders from these animals. In addition, differences in micronutrient concentrations were determined between the two value cuts.

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2. Materials and methods

2.1. Sample description

Cross-bred beef steers were fed finishing rations containing 0% and 40% WDGS DM with and without supplemental vitamin E (500 IU/steer top-dressed daily) for 140 days at the University's Agricultural Research and Development Center research feedlot near Mead, NE, USA. The diets met the nutrient requirements of beef cattle (U.S. National Research Council, 2000). The WDGS from corn contained 32.7% dry matter (DM). On a DM basis, WDGS contained 32.6% crude protein, 11.5% crude fat, and 42.4% fiber. The 0% WDGS DM diet fed to some of the steers contained 82.5% corn (1:1 ratio of dry-rolled and high moisture corn on a DM basis) and 5% molasses, whereas the 40% WDGS DM diets contained 40% WDGS and 47.5% corn. Steers fed the basal level of vitamin E received 23.6 IU α-tocopherol/kg in the 0% WDGS diet and 45.3 IU/kg in the 40% WDGS diet. All animal care procedures were conducted in accordance with the University's Institute for Animal Care and Use Committee.

Value meat cuts graded as choice from 29 steers were included in the current study. The number of steers in each animal treatment group was: 0% WDGS and basal vitamin E ($n = 6$), 0% WDGS and supplemental vitamin E ($n = 7$), 40% WDGS and basal vitamin E ($n = 8$), and 40% WDGS and supplemental vitamin E ($n = 8$). The steers were slaughtered on day 140 at a commercial abattoir (Greater Omaha Pack, Omaha, NE, USA); the steers were approximately 17 months of age. Final body weights and hot carcass weights of the steers were recorded. Shoulder clods were removed, vacuum packed, kept at 5 °C, and then transported to the University's Loeffel Meat Laboratory and aged for 7 days at 1 °C. Flat iron steaks (North American Meat Processors Association #114D) were filleted from both shoulder clods and the connective tissue that runs through the middle was removed. Petite tenders (North American Meat Processors Association #114F) were fabricated from both shoulder clods. For micronutrient analyses, representative portions of the meat samples large enough to ensure uniform lipid content (to equalize the influence of invisible fat) including representative portions of the outside portion of the cut, were homogenized with liquid nitrogen, stored at −80 °C, and thawed at 5 °C before each analysis.

2.2. Micronutrient analyses

The vitamin and mineral concentrations that were quantified in these meat cuts were: α-tocopherol, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, calcium, phosphorus, magnesium, potassium, sulfur, iron, copper, zinc, manganese, and sodium. These are nutrients found in red meats that Americans reportedly consume in lower or higher amounts than recommended (U.S. Department of Agriculture, 2008). The moisture and total lipid concentrations were also determined (AOAC, 2006). Analyses for each nutrient were performed in duplicate for both meat cuts from all 29 steers. The nutrient contributions of these vitamins and minerals determined to be in these meat cuts to the dietary needs of humans age 4 years and older, excluding pregnant and lactating women, were estimated as percentages of the Daily Values (U.S. Food and Drug Administration, 2008), the nutrient recommendations established by the U.S. Food and Drug Administration for nutrition labeling.

The α-tocopherol concentrations of the meat samples as well as the finely ground corn top-dressings containing or not containing the supplemental vitamin E in the animal diets were analyzed using HPLC techniques (Chun et al., 2006; Kim et al., 2007). Thiamin, riboflavin, and niacin were determined using the HPLC procedure of Dawson et al. (1988). The vitamin B_6 and vitamin B_{12} concentrations of the samples were determined by microbiological assays (Sauberlich, 1967; AOAC, 2006) using *Saccharomyces uvarum* (ATCC 9080) and *Lactobacillus leichmannii* (ATCC 7830), respectively. These methods or similar methods had been used previously in our laboratory for determining the selected vitamin content of several cuts from bison (*Bison bison*) (Driskell et al., 1997, 2000).

The identities of the vitamins were confirmed by standard addition (spiking) of beef samples with the appropriate vitamin before extraction; vitamin recoveries were >90%. The extraction method and the HPLC or microbiologic analytic methods were also validated using Standard Reference Material 2383 (baby food composite, U.S. National Institute of Standards and Technology, Gaithersburg, MD, USA). The coefficients of variance for all vitamins were <10%. All content values are expressed on a wet weight (w/w) basis.

Representative portions of the meats were provided to Ward Laboratories Inc. (Kearney, NE, USA) for analyses of the minerals calcium, phosphorus, magnesium, potassium, sulfur, iron, copper, zinc, manganese, and sodium. The concentrations of these minerals in the meat samples were determined by atomic absorption spectroscopy (AOAC, 2006). All content values are expressed w/w.

2.3. Statistical analyses

All data were analyzed using the mixed model ANOVA procedure (Dowdy et al., 2004) implemented in PROC MIXED (SAS version 9.1, 2002–2003, Cary, NC, USA). Animal was treated as the experimental unit, and the responses were modeled as a 2 × 2 factorial with the factors of WDGS treatment (0 or 40%), vitamin E supplementation (basal or 500 IU/day), and WDGS treatment × vitamin E supplementation interaction. The micronutrient content of the two meat cuts were also compared using the mixed model procedure with the experimental unit being cut. The data are given as LS mean ± SE. Differences were considered significant at $P < 0.05$.

3. Results

The steers received either 23.6 or 45.3 IU α-tocopherol/kg from the finishing diets containing basal levels of the vitamin; these steers consumed around 11–12 kg DM diet/day. Steers that received supplemental vitamin E were fed an additional 500 IU α-tocopherol daily. Final body weights of the 29 steers ranged from 551 to 683 kg and hot carcass weights ranged from 347 to 436 kg. Marbling scores (mean = 623) were not different among the treatments.

The mean weights of flat iron steaks and petite tenders were 384.0 and 413.6 g, respectively. The moisture and total lipid concentrations of flat iron steaks from steers in the four treatment groups were similar, as was also true for the petite tenders. The mean moisture and total lipid concentrations of the flat iron steaks were 69.5 and 13.2 g/100 g, respectively, while that for the petite tenders were 73.2 and 8.6 g/100 g, respectively.

Few differences in selected vitamin and mineral concentrations of flat iron steaks (Table 1) and petite tenders (Table 2) by WDGS, by vitamin E supplementation, and by WDGS × vitamin E supplementation were observed. Much individual variation was observed in these micronutrient concentrations. Niacin concentrations were particularly variable in both cuts, ranging from 1.621 to 6.198 mg/100 g (w/w) in flat iron steaks and from 2.324 to 3.781 in petite tenders. Vitamin B_{12} concentrations were significantly lower ($P = 0.0191$) and sodium concentrations were significantly higher ($P = 0.0270$) in flat iron steaks from steers fed 40% WDGS than 0%. As expected, α-tocopherol concentrations were signifi-