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The influence of forage diets and aging on beef palatability

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ABSTRACT

To investigate the influence of diet and aging on beef palatability, lipid oxidative stability, and fatty acid composition, crossbred steers were assigned to Feedlot S (alfalfa and grain), Forage TR (triticale and annual ryegrass), Forage TK (triticale and kale), or Forage + Feedlot (grazing ryegrass, fescue and orchardgrass, finished on alfalfa and grain) dietary treatments. Heifers were finished on Feedlot H (alfalfa and grain). Longissimus and tricep muscles were sampled from these animals for steaks and ground beef, respectively. Steaks were either dry- or wet-aged for 14 d. Ground beef was dry-aged, wet-aged for 14 d, or not aged. Trained sensory panelists evaluated palatability attributes of steaks and ground beef. Diet did not influence sensory attributes of steaks or ground beef. Aging impacted ($P<0.05$) sensory attributes of ground beef. Diet and aging had no impact on lipid oxidative stability but affected fatty acid composition of raw ground beef.
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1. Introduction

Palatability is one of the important factors in beef quality. Palatability is related to tenderness, flavor, and juiciness (Umberger, Feuz, Calkins, & Killinger, 2000). Several pre- and post-harvest management practices were demonstrated to impact beef palatability. For example, grass-fed beef has been criticized for lower palatability (Hedrick, 1983). Larick et al. (1987) suggested the greatest sensory difference between grain- and forage-fed beef was the flavor of fat. In addition, Mitchell, Reed, and Rogers (1991) reported that forage finishing had a negative effect on beef tenderness. However, Marino et al. (2006) found no influence of diets, with different forage to concentrate ratios, on beef flavor or tenderness determined by instrumental and sensory approaches. Post-harvest techniques are used to improve eating quality of beef or minimize the impact of diet. One of the most popular options is postmortem aging. It has been well accepted that postmortem aging can increase meat tenderness. However, controversy still exists about the influence of aging on palatability aspects other than tenderness, such as aroma, flavor, and juiciness (Gorraiz, Beriain, Chasco, & Insausti, 2002; Stetzer, Tucker, McKeith, & Brewer, 2007).

Most studies have used beef steaks to investigate the influence of diet or aging on beef palatability, and few studies have been conducted to explore the interaction between dietary systems and aging methods. Therefore, the main objectives of this study were to study the influence of diet, aging, and their interaction on palatability attributes of both beef steaks and ground beef. Different from other papers which compared forage and typical concentrate diets, we studied different forage diets, feedlot diets relatively low in grains and a pasture-feedlot combined feeding system.

2. Materials and methods

This experimental protocol was approved by the University of Nevada-Reno (UNR) Animal Care Committee. All procedures conformed to the Guide for the Care and Use of Agricultural Animals in Research and Teaching (FASS, 1999).

2.1. Animals and pre-, post-harvest management

Crossbred steers (mostly 50% Angus) were assigned to one of the following dietary treatments in a completely randomized design (CRD): Feedlot S (alfalfa and grain), Forage TR (grazing triticale and annual ryegrass, finished on hay harvested from the other half of the field), Forage TK (grazing triticale and kale, finished on hay harvested from the other half of the field), and Forage + Feedlot (grazing a pasture mix of ryegrass, fescue and orchardgrass, finished on alfalfa and grain). Heifers were finished on Feedlot H (alfalfa and grain). Diets were formulated to meet or exceed NRC (1996) requirements and be equalized in net energy above maintenance so that all the animals achieved the same ending body weight (577.2 ± 12.90 kg). The animals fed Forage and Forage + Feedlot diets were grazing their pasture for 3 months while the other animals were housed in a feedlot. Then all the animals were housed in the feedlot for 236.5 ± 16 d and fed either their hay or feedlot

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diets. The weight of cattle entering the feedlot was 375.0 ± 8.55 kg and their average daily gain (ADG) in the feedlot was 0.9 ± 0.03 kg/d.

Within Forage + Feedlot diet, steers were fed a feedlot diet comprised of 87.4% alfalfa, 12.5% commercial grain mixture and 0.07% minerals. Within Feedlot S diet, for the first 31 d steers were fed a diet comprised of 87.5% alfalfa, 12.3% cracked corn and 0.3% minerals to gain 1.45 kg/d; for the next 38 d steers were fed a diet comprised of 75.6% alfalfa, 13.5% cracked corn and 10.9% grain screenings to gain 1.2 kg/d; from day 69 to slaughter steers were fed a diet comprised of 71.2% alfalfa, 15.5% cracked corn and 13.3% grain screenings to gain 1.17 kg/d. Within Feedlot H diet, for the first 38 d heifers were fed a diet comprised of 86.9% alfalfa and 13.1% cracked corn to gain 1.2 kg/d; for the next 46 d heifers were fed a diet comprised of 71.3% alfalfa, 14.5% grain screenings and 14.1% cracked corn to gain 1 kg/d, from day 47 to slaughter heifers were fed a diet comprised of 85.6% alfalfa and 14.4% cracked corn to gain 1.25 kg/d. The nutrient composition (AOAC, 2007) of the harvested forages and commercial grain mixture are shown in Tables 1 and 2, respectively.

Animals were harvested at the UNR Meat Laboratory following USDA humane slaughter procedures when they were 724 ± 15 d of age. Five and four animals were sub-sampled from each dietary treatment, respectively, to get steaks and ground beef samples. Two 2.5 cm-thick longissimus muscle steaks and three trimmed triceps muscle samples were collected from each animal. Steaks were either wet-aged in vacuum bags or dry-aged on the carcass for 14 d at 2 °C. Trimmed triceps muscle samples were un-aged (removed from carcass at 2 d postmortem, vacuum packaged, and immediately frozen), dry-aged on the carcass, or wet-aged in vacuum bag for 14 d at 2 °C. At the end of the assigned aging periods unpackaged samples were vacuum packaged and all samples were frozen at −30 °C. Frozen samples were shipped to the Washington State University Meat Laboratory.

2.2. Sample preparation

Triceps muscle samples were partially thawed at 2 °C, cut into pieces and ground through a table top meat grinder (model MG-203100; BUNZL Processor Division, Kennewick, WA). Samples were ground once through a coarse cutting plate (1 cm diameter) and then through a fine cutting plate (0.5 cm diameter). Ten cm-diameter and 1.5 cm-thick patties were made by a hand patty maker (Progressive International, Kent, WA) and then frozen and stored at −20 °C for up to one week. Fifty beef steaks and sixty ground beef samples were subsequently cooked and evaluated for palatability by trained laboratory panels.

Table 1
Nutrient composition of the harvested forages (based on dry matter).

Item[a]	Unit	Feeds			
		Alfalfa	Ryegrass/orchardgrass/fescue	Triticale/kale	Triticale/ryegrass
		Level			
CP	%	19.75	8.21	12.63	12.32
Soluble CP	% of CP	29.00	29.00	29.00	29.00
NFC	%	31.44	23.45	27.39	24.25
EE	%	1.31	1.83	1.47	1.04
NDF	%	37.91	54.10	46.41	52.47
ADF	%	25.05	34.92	30.24	33.93
Lignin	%	4.86	6.92	5.94	6.72
Ash	%	9.58	12.42	12.11	9.91
Ca	%	1.13	0.43	0.72	0.31

(AOAC, 2007).
[a] CP = crude protein, NFC = non-fiber carbohydrate, EE = ether extract, NDF = neutral detergent fiber, ADF = acid detergent fiber.

Table 2
Guaranteed analysis of commercial grain screenings (based on dry matter).

Item[a]	CP	EE	CF	Ca	P	Na	Se
Level	10.0%	2.5%	6.0%	0.25%	0.3%	2.0%	0.75 ppm

[a] CP = crude protein, EE = ether extract, CF = crude fiber.

Steaks were thawed at 3–4 °C for 48 h, weighed and then cooked on a preheated (229 ± 5 °C) Alfredo Healthy Grill (model BG-16; DeLonghi, Shelton, CT). Geometric center temperature was monitored by a 12-Channel Scanning Thermocouple Thermometer (Model 692-8010, Barnart, Barrington, IL). Steaks were turned when the internal temperature reached 40 °C and removed at 71 °C (3.5–4 degree of doneness; Romans, Costello, Carlson, Greaser, & Jones, 2001). Steaks were weighed, then slice shear force (SSF) was determined by using a method adapted from that described by Wheeler, Shackelford, and Koohmaraie (2007). A 4 cm-long slice was used instead of a 5 cm-long slice to avoid overloading the 25 kg capacity of the shearing device. Slices were cooled to room temperature (21 °C) and measured on a TA-XT2 Texture Analyzer (Texture Technologies, Scarsdale, NY) fitted with a blade designed for SSF. The slices were positioned so that they would be sheared in the center, perpendicular to the muscle fibers along the 4 cm dimension of the slices. The remainder of the steak was trimmed of visible connective and fat tissue, cut into 1 × 1 × 2.5 cm cubes and then served warm to the sensory panel.

Frozen patties were weighed and cooked on a preheated (182 ± 2 °C) George Foreman grill (model GR12; Salton, Miramar, FL) for about 8 min to reach a central temperature of 68 °C, monitored by a 12-Channel Scanning Thermocouple Thermometer (Model 692-8010, Barnart, Barrington, IL). Then the patties were removed, weighed again and wrapped in aluminum foil (where temperature of patties increased about 3 °C) until being cut into twelve pie-shaped pieces for sensory evaluation.

2.3. Sensory evaluation

Two nine-member trained sensory panels were conducted to evaluate palatability attributes of beef steaks and ground beef (AMSA, 1995), respectively. Samples were randomly assigned to sessions. Six warm samples per session were served to panelists in individual booths under fluorescent light (512 ± 13 lx, measured by a Traceable Dual-range Light Meter, Control, Friendswood, TX). A maximum of one morning and one afternoon session were conducted per day. Steaks were evaluated for beef flavor intensity, off-flavor, initial tenderness, sustained tenderness, and juiciness; and ground beef for beef aroma intensity, off-aroma, beef flavor intensity, off-flavor, tenderness, and juiciness on 10-cm unstructured line scales labeled at each end (Stone & Sidel, 1985). Each panelist was supplied unsalted crackers to cleanse the palate, distilled water to rinse, and a cup for expectoration. A ruler was used to determine the panelists' scores and the results were expressed in centimeters.

2.4. Lipid oxidation measurement

All 60 raw ground beef samples and 33 of the cooked ground beef samples were collected to assess the amount of lipid oxidation using the 2-thiobarbituric acid reactive substances (TBARS) assay (Tarladgis, Watts, Younathan, & Dugan, 1960). Approximately 100–200 mg tissue pieces were pre-weighed and homogenized with an Omni Tissue Homogenizer (Omni Int., Marietta, GA) in 1 ml of RIPA Buffer (50 mM Tris–HCl, pH 8.0, with 150 mM sodium chloride, 1.0% Igepal (NP-40), 0.5% sodium deoxycholate, and 0.1% sodium dodecyl sulfate) (Sigma R0278) with a protease inhibitor cocktail (Sigma P2714). Tissue homogenates were centrifuged at 3000 × g at 4 °C for 10 min in a Sorvall table top centrifuge (Thermo Fisher Scientific, Waltham, MA). A 100 µl aliquot of the supernatant from each sample was removed,

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