Meat and Muscle Biology™

Fresh Beef Quality From Cattle Fed Field Peas During Pasture and Finishing Phases of Production

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Abstract: This study evaluated the effects of field peas during 2 phases of production on fresh beef quality. Cattle ($n = 228$) were randomly assigned to one of 6 dietary treatments consisting of 3 pasture and 2 finishing supplementations. The pasture phase consisted of (1) no supplement, (2) field peas at 0.5% body weight, or (3) dry-rolled corn supplement at 0.5% body weight. The finishing phase consisted of (1) no field peas or (2) field peas at 20% dry-matter basis. Strip loin samples were aged for 14 d and subjected to retail display for an additional 7 d. Tenderness via Warner-Bratzler Shear Force and Slice Shear Force, objective (L*, a*, and b*) and subjective color, lipid oxidation (thiobarbituric acid reactive substances), and fatty acid composition were evaluated. Dietary treatment had no effect on tenderness. Steak discoloration was low (<3%) for all treatments ($P = 0.0209$). Additionally, all objective color measurements displayed interactions between pasture and finishing diets (L*, $P = 0.0035$; a*, $P = 0.0189$; b*, $P < 0.0001$). These interactions were statistically significant, yet no consistent patterns among treatments could be identified. Similarly, the magnitude of difference would require extended aging periods to visually influence the color differences perceived by consumers. Beef finished with field peas had slightly greater lipid oxidation than samples from cattle not receiving field peas during finishing (1.56 vs. 1.44 mg malonaldehyde/kg tissue, respectively; $P = 0.0541$). There was a significant interaction between pasture and finishing treatments for C15:1 ($P = 0.0331$), whereas feeding field peas during the pasture phase increased C18:2 ($P = 0.0381$) relative to cattle supplemented with corn; cattle without supplement in the pasture phase had intermediate amounts of C18:2. Total saturated, unsaturated, monounsaturated, and polyunsaturated fatty acids ($P > 0.05$) were unaffected by dietary treatments. Field peas may be used for cattle with minimal negative impact on fresh meat quality.

Key words: beef, fatty acid composition, field peas
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Introduction

Field pea (*Pisum sativum*) production has grown rapidly within the northern Great Plains states due to climate adaptability and agronomic benefits, including fixing nitrogen in soil. As the availability of field peas increases, the portion of the crop that does not meet quality standards for human consumption is being considered as an alternate nutritional feedstuff for livestock production.

Because of their nutritional value, field peas have been used as a protein supplement in ruminants (Soto-Navarro et al., 2012; Vander Pol et al., 2008; Vander Pol et al., 2009) and as an energy source for monogastrics (Smith et al., 2013). Slight to no differences have been found in carcass quality or yield grades with the inclusion of field peas (Lardy et al., 2009; White et al., 2015). Researchers have also focused on tenderness differences and sensory panel response, and results indicate that dietary field pea inclusion does not negatively impact beef palatability (Carlin et al., 2013). However, to date, fatty acid profile determination of beef fed field peas has not yet been defined.

The decision to utilize field peas in growing and finishing rations is based on cost, availability, and nutrient characteristics of the ration. While dietary inclusion has indicated no negative results for live animal performance, limited research has evaluated the effect of field peas on fresh meat quality, particularly fresh meat quality past yield and quality grades. Therefore, the objective of this study was to determine the impacts of field peas on meat quality, more specifically evaluation for treatment differences on (1) Warner-Bratzler Shear Force (WBSF) and Slice Shear Force (SSF) as indications of tenderness, (2) retail display (RD) and fat oxidation, which impacts shelf-life and consumer acceptance of fresh beef, and (3) beef fatty acid profile.

Materials and Methods

Cattle and dietary treatments

University of Nebraska-Lincoln's Animal Care and Use Committee approved of all animal protocols (Institutional Animal Care and Use Committee protocol #902). A total of 228 crossbred cattle (Angus × Angus-Continental; steers during y 1, heifers during y 2) were used in a randomized complete block with a 3 × 2 factorial arrangement of treatments including 3 pasture treatments on crested wheatgrass pastures either (1) with no supplement; (2) with whole, unprocessed field peas at 0.5% body weight (BW); or (3) with dry-rolled corn supplemented at 0.5% BW (70.8% dry-rolled corn, 24% condensed distillers solubles, 5.2% urea). Groups received one of two finishing treatments: (1) no field peas added to the diet or (2) supplemented with field peas (20% dry-matter basis; Table 1; Greenwell et al., 2017). Cattle were weighed on day −1 and 0, sorted into 3 BW blocks, and assigned to one of 12 pastures. The 12 groups (4 replications per treatment per year) were rotated through pastures biweekly to ensure that pasture differences did not affect treatments. Upon arrival to the feedlot (University of Nebraska-Lincoln Panhandle Research and Extension Center, Scottsbluff, NE), all cattle remained in their respective grazing groups in one of 12 pens. Steers were fed for approximately 119 d in the feedlot during y 1, whereas the heifers were finished for 131 d during y 2. The sex effect was not significant ($P = 0.8786$), and therefore sex was removed from the statistical model.

Table 1. Finishing diet composition of cattle ($n = 228$) fed field peas (20% DM basis) or no supplement during the finishing phase of production

	Finishing treatment	
Ingredient, %	No field peas	Field peas
Dry-rolled corn	60.0	40.0
Field peas	0.0	20.0
WDGS	20.0	20.0
Corn silage	14.0	14.0
Mineral supplement[1]	6.0	6.0
Crude protein	13.1	16.4
Neutral detergent fiber	18.2	18.0
Crude fat	4.2	3.7
Ash	3.5	3.9

[1]Supplement included monensin at a rate of 360 mg/head per day and tylosin at 90 mg/head per day; 8% crude protein, 0.5% crude fat, 4.7% calcium, 0.06% phosphorus, 3.5% salt, 3.8% potassium, and 4,918 IU/kg of vitamin A.

DM = dry matter; IU = international units; WDGS = wet distillers grains with solubles.

Sample collection and fabrication

All cattle were slaughtered at Tyson Fresh Meats Inc. (Lexington, NE). Carcasses were chilled for 24 h before marbling attributes were evaluated by a United States Department of Agriculture beef carcass supervisor. After grading, an approximate 7.62-cm-thick slice of the anterior portion of the strip loin (*M. longissimus lumborum*) was collected at the 12th/13th rib area from each side of every carcass. All samples were vacuum packaged and transferred to the Loeffel Meat Laboratory at the University of Nebraska-Lincoln. Samples were immediately deboned by hand and were cut using a slicer (SE 12D manual slicer; Bizerba, Piscataway, NJ). The samples taken from the right side of the carcass were used for tenderness evaluation and fatty acid analysis. After facing the surface on both sides (<0.635 cm), a 2.54-cm steak was cut for WBSF and SSF testing for d 0 of RD, and the remaining portion was used for fatty acid analysis. Samples taken from the left side of the carcass were placed under RD for tenderness, color, and lipid oxidation evaluation. After facing the surface of both sides (<0.635 cm), a 2.54-cm steak was cut for WBSF and SSF testing at d 7 of RD. These same steaks were used for objective and subjective color evaluation during RD, and the remaining portion was used for thiobarbituric acid reactive substances (TBARS). Samples for TBARS for d 0, 4, and 7 came from one steak (1.27-cm thick) that was divided into 3 portions and trimmed of all subcutaneous fat. The d-0 portion of the steak was also used for proximate analysis. The steaks that were

used to evaluate fatty acid composition and lipid oxidation were vacuum packaged using a MULTIVAC 500 (Multivac Inc., Kansas City, MO) in Prime Source vacuum pouches (15.24 × 25.4 cm 3-mil Standard Barrier). Steaks for tenderness evaluation and RD were packaged with an INTACT machine (Cryovac Inc., Kansas City, MO) and placed in boxes for the aging process. All samples were aged for 14 d (2°C) under dark storage. After aging, steaks for visual discoloration, tenderness, and lipid oxidation were removed from packaging, placed on foam trays (21.6 × 15.9 × 2.1 cm; Styro-Tech, Denver, CO), overwrapped with oxygen-permeable film (polyvinyl chloride–overwrap; PSM18, Prime Source, St. Louis, MO), and placed under RD conditions for 4 and 7 d (2.7°C under white fluorescence lighting at 1,000 to 1,800 lx). Steaks used for fatty acid profile and proximate composition had 0 d of RD and were frozen for further analysis (−80°C). Subsequently, samples trimmed of all subcutaneous fat for proximate analysis, fatty acids, and lipid oxidation were frozen in liquid nitrogen and powdered in a metal cup blender (Model 51BL32; Waring Commercial, Torrington, CT). Powdered samples were stored at −80°C.

Objective color (L*, a*, and b* values) and subjective color (visual discoloration)

Objective color measurements were taken daily for 7 d at about 10 AM. Measurements were obtained for Commission Internationale de l'Éclairage (CIE; "International Commission on Illumination") L*, a*, and b* values using a Minolta CR-400 colorimeter (Minolta, Osaka, Japan) set at a D65 light source and 2° observer with an 8-mm-diameter measurement area. The colorimeter was calibrated daily using a white ceramic tile provided by the manufacturer, and color measures were obtained by averaging 6 readings from different areas of the steak surface. The CIE L* measured lightness (black = 0; white = 100), a* measured redness (red = positive values; green = negative values), and b* measured yellowness (yellow = positive values; blue = negative values).

Visual discoloration was assessed daily during RD with a trained 6-person panel. Panelists were provided a visual discoloration guide to use as a reference. A percentage scale was used in which 0% meant no discoloration and 100% meant complete discoloration. Panelists were instructed to perform the evaluation at the same time each day to minimize variation. Samples were randomly rotated daily to minimize any possible location effects.

Tenderness evaluation: WBSF and SSF

Steaks from the right side of the carcass were used to evaluate tenderness on d 0 of RD, while steaks from the left side of the carcass were used to measure tenderness on d 7 of RD. Steaks were never frozen, and internal raw temperatures and weights were recorded prior to cooking. Steaks were cooked to a target temperature of 71°C on a Belt Grill (TBG60-V3 MagiGril; MagiKitch'n Inc., Quakertown, PA). Belt Grill settings were as follows: preheat = 149°C; top heat = 163°C; bottom heat = 163°C; height of gap = 2.16 cm; and cook time of approximately 5.5 min. After cooking, an internal temperature and weight were recorded, and SSF evaluation was conducted using a Food Texture Analyzer (model TMS-PRO; Food Technology Corporation, Sterling, VA) with an SSF blade. The remainder of the steak was individually bagged and stored in a cooler (maintained at 3°C). Approximately 24 h after SSF evaluation was conducted, 6 cores (1.27-cm diameter) were removed parallel to the muscle fiber orientation of each steak and were measured with a Food Texture Analyzer with a Warner-Bratzler blade.

Lipid oxidation

Lipid oxidation was determined for steaks under simulated RD conditions for 0, 4, and 7 d with the TBARS protocol as described by Ahn et al. (1998). Steaks for lipid oxidation were divided into 3 portions and randomly assigned by day (0, 4, or 7), and then each portion was subsequently powdered. Approximately 5 g of powdered sample was weighed into a 50 mL conical tube to which 14 mL of deionized distilled water and 1 mL of beta hydroxyl anisole (10% beta hydroxyl anisole:90% ethanol) were added. After polytroning for 15 s, the samples were centrifuged (2,000 *g* for 5 min); 1 mL of the supernatant was transferred to a 15 mL conical tube, and 2 mL of tertiary butyl alcohol/trichloroacetic acid solution (15% trichloroacetic acid and 20 mM tertiary butyl alcohol in deionized distilled water) was added and vortexed before placing samples in a water bath (70°C for 30 min). After cooling, samples were centrifuged (2,000 *g* for 5 min), and 200 µL of supernatant was transferred to 96-well plates. All 96-well plates had standards to calculate standard curves and ultimately milligrams of malonaldehyde per kilogram of tissue read at 540 nm.

Proximate analysis

Proximate analysis was conducted to determine fat, moisture, and ash content; protein content was

determined by difference. Fat was quantified following ether extraction (AOAC method 920.39c; AOAC, 1990). Samples were measured in triplicate in Whatman #2 filter paper, and fat was extracted with anhydrous ether. Fat percentages were averaged per sample and were later used to convert fatty acid percent data to milligrams per 100 g of tissue. Moisture and ash were determined with a LECO thermogravimetric analyzer (Model 604-100-400; LECO Corporation, St. Joseph, MI), and samples were measured in duplicate. Moisture was determined in a nitrogen atmosphere with a start temperature of 25°C and an end temperature of 130°C (~17-min ramp rate). Ash was determined in an oxygen atmosphere with a start temperature of 130°C and an end temperature of 600°C (30-min ramp rate).

Fatty acid composition

Total lipid was extracted following the chloroform-methanol procedure of Folch et al. (1957) with modifications detailed by Morrison and Smith (1964) and Metcalfe et al. (1966). Briefly, 1 g of powdered sample was weighed into a 15 mL conical tube, to which 5 mL of 2:1 chloroform:methanol was added and vortexed for 5 s. After 1 h, samples at room temperature were filtered through Whatman #2 filter paper onto a 13 × 150 mm glass screw cap tube, volume was brought up to 10 mL with 2:1 chloroform:methanol, and 2 mL of KCl was added and vortexed. After centrifuging samples (1,000 *g* for 5 min), the top organic matter layer was aspirated off, and samples were dried down completely on a heating block (60°C) under constant nitrogen purge. One-half milliliter of 0.5 M NaOH in methanol was added, vortexed, and heated (100°C) for 5 min. Then, boron trifluoride in 14% methanol (0.5 mL) was added, vortexed, and heated (100°C for 5 min). Subsequently, 1 mL of saturated salt solution and 1 mL of hexane were added, and samples were centrifuged (1,000 *g* for 5 min). The top hexane layer was carefully pipetted into gas chromatography glass vials and nitrogen purged, and lids were immediately crimped on. Chromatography was done using a Chromopack CP-Sil (0.25 mm × 100 m) column with an injector temperature of 270°C and a detector temperature of 300°C (Hewlett-Packard 6890 FID GC System; Agilent Technologies, Santa Clara, CA). The head pressure was set at 275 kPa (40 psi) with a flow rate of 1.0 mL/min. The fatty acids were identified by their retention times in relation to known standards (Nu-Chek Prep Inc., Elysian, MN; #GLC-68D, GLC-79, GLC-87, GLC-455, and GLC-458), and the percentages of fatty acids were determined by the peak areas in the chromatograph. Values were adjusted according to their fat percentage, and values were converted to milligrams per 100 g of tissue.

Statistical analysis

This study was replicated over 2 y. There were 3 pasture diets and 2 finishing diets. For shear force (tenderness), aging was included as a main effect. For color variables, main effects were pasture diet, finishing diet, and RD time. Main effects and interactions were analyzed using SAS version 9.4 (SAS Institute Inc., Cary, NC). Individual animal served as the experimental unit. All strip loin samples were aged for 14 d and subjected to RD for an additional 7 d. Discoloration data were analyzed with the slice function of SAS, slicing by day of RD. All other analyses were conducted with "PROC GLIMMIX"; means were separated with the "LS MEANS" statement, and Tukey adjustment was made. An alpha level of 0.05 was used, and tendencies were considered at an alpha level of 0.10.

Results and Discussion

Quality grade assessment

In this study, every side from all carcasses was sampled, regardless of treatment. Due to both sides being used for various laboratory analyses, the marbling scores were collected and averaged for the overall carcass. After the marbling scores were averaged, the grade distribution was calculated for the total number of samples and was as follows: 2.2% low Prime, 11.2% high Choice, 33.5% average Choice, 42.8% low Choice, and 10.3% Select. There were no quality grade differences due to dietary treatment ($P > 0.05$).

Color evaluation

Visual discoloration had a triple interaction between RD, pasture, and finishing diets ($P = 0.0209$; Table 2). As expected, discoloration increased as RD time increased. Studies have reported a decline in the purchasing of RD beef when surface discoloration was equal to or greater than 20% (Hood and Riordan, 1973). However, in the current study, samples only reached an average of 1.47% discoloration by d 7 irrespective of dietary treatment during both combined years. Based on these findings, no perceivable differences can be attributed to a particular treatment with beef aged for 14 d with a 7-d RD period. Beef

Table 2. Discoloration (%) of strip loin steaks (*longissimus lumborum*) aged for 14 d from cattle fed corn, field peas, or no supplement during the pasture and finishing phases of production

Treatment		Days on RD							
Pasture phase	Finishing phase	0	1	2	3	4	5	6	7
No supplement	Corn	0.00	0.00	0.00	0.01	0.01	0.10	0.41^{a}	0.84^{a}
No supplement	Field pea	0.00	0.03	0.03	0.03	0.17	0.32	1.15^{b}	2.01^{c}
Field peas	Corn	0.00	0.00	0.00	0.01	0.11	0.18	0.86^{ab}	1.62^{bc}
Field peas	Field pea	0.00	0.01	0.02	0.02	0.08	0.30	0.68^{ab}	1.33^{ab}
Corn	Corn	0.00	0.02	0.04	0.07	0.14	0.28	0.70^{ab}	1.63^{bc}
Corn	Field pea	0.00	0.01	0.01	0.02	0.03	0.09	0.48^{a}	1.31^{ab}

$^{a–c}$Means within a column with a different superscript are different ($P < 0.05$).

Overall interaction of Pasture × Finish × RD ($P = 0.0209$). SEM = 0.1724.

RD = retail display; SEM = standard error of the mean.

is typically aged 7 to 35 d in the US (Savell, 2008), and therefore it can be concluded that the inclusion of field peas in cattle diets does not negatively impact fresh beef color for short-term aging periods. In order to reach greater discoloration magnitudes that would be perceivable to consumers, and further evaluate the effects of these dietary treatments on color stability, extended aging periods would be required.

All objective color measurements displayed interactions between pasture and finishing diets (L*, $P = 0.0035$; a*, $P = 0.0189$; b*, $P < 0.0001$; Table 3). The L* and a* measurements followed similar patterns among dietary treatments in which cattle fed additional protein sources (corn or field peas) during both the grazing and finishing treatments displayed beef with darker L* values and more negative a* values. Even though L* and a* interactions were statistically significant, it should be noted that these values only ranged between 44.52 and 43.96 and between 21.47 and 21.00, respectively. No consistent patterns for b* measurements among treatments could be discerned.

Table 3. Objective color values of strip loin steaks (*longissimus lumborum*) aged for 14 d from cattle fed corn, field peas, or no supplement during the pasture and finishing phases of production

Treatment		Objective color		
Pasture phase	Finishing phase	L*	a*	b*
No supplement	Corn	44.5^{c}	21.5^{c}	10.3^{c}
No supplement	Field peas	44.1^{ab}	21.1^{ab}	9.9^{ab}
Field peas	Corn	43.9^{a}	21.1^{ab}	10.0^{abc}
Field peas	Field peas	44.2^{ab}	21.0^{a}	9.8^{a}
Corn	Corn	44.2^{ab}	21.1^{ab}	9.9^{ab}
Corn	Field peas	44.4^{ab}	21.3^{ab}	10.1^{bc}

$^{a–c}$Means within a column with a different superscript are different ($P < 0.05$).

Overall interaction of Pasture × Finish × RD (L*, $P = 0.0035$; a*, $P = 0.0189$; b*, $P < 0.0001$). SEM L* = 0.1724; a* = 0.0982; b* = 0.0541.

RD = retail display; SEM = standard error of the mean.

Tenderness

Tenderness was measured with WBSF and SSF, and a strong correlation between both methods was observed ($r = 0.65$; $P < 0.0001$). On average, tenderness increase (shear force decreased) as days of RD increased (3.61 vs. 2.90 and 17.92 vs. 15.26, respectively; $P < 0.0001$), and neither backgrounding nor finishing treatment influenced tenderness measurements. Previously, Hinkle et al. (2010) reported that WBSF values decreased linearly as field peas increased in the diet (0%–30% inclusion rate fed to yearling steers for 119 d), with the lowest shear force value occurring at the greatest inclusion level of peas, suggesting that field peas had a positive effect on beef tenderness. Carlin et al. (2013) conducted 2 experiments: one had similar results to those of Hinkle et al. (2010) indicating there was an improvement in tenderness with field peas (0%–30% inclusion rate in finishing diets of steers and heifers), whereas the other experiment concurred with the current study implicating that the addition of field peas had no effect on beef tenderness. In the cases in which there were improvements in tenderness associated with feeding field peas, a linear decrease in calpastatin activity was reported as dietary field peas increased in the diet. It is well known that the calpain-calpastatin system has an important role in tenderization of meat (Geesink et al., 2006) and that decreased levels of calpastatin result in more tender meat, which would in part explain the positive effects of field peas on meat tenderness reported in the literature.

Lipid oxidation

Lipid oxidation was determined with the TBARS protocol as described by Ahn et al. (1998), which was modified from Beuge and Aust (1978). Lipid oxidation generates byproducts that are responsible for the development of off-flavors in meat products (Greene, 1969) and are undesirable to consumers at elevated amounts. The current study indicated that meat from cattle finished with field peas had slightly greater lipid oxidation than samples from cattle not receiving field peas during finishing (1.56 vs. 1.44 mg malonaldehyde/kg tissue, respectively; $P = 0.0541$). However, such low TBARS values would not be considered perceivable to consumers. As expected, lipid oxidation increased over time under simulated RD (d 0 = 0.94; d 4 = 1.46; and d 7 = 2.11 mg malonaldehyde/kg tissue; $P < 0.0001$).

Table 4. Fatty acid[1] composition of beef (*longissimus lumborum*) from cattle fed corn, field peas, or no supplement during the pasture and finishing phases of production

	No supplement on pasture		Field peas on pasture		Corn on pasture		*P* value			
Fatty acid	Corn finishing	Field peas finishing	Corn finishing	Field peas finishing	Corn finishing	Field peas finishing	Pasture	Finishing	Pasture × finishing	SEM
C10:0	3.9	5.1	5.4	5.1	4.4	4.5	0.28	0.52	0.44	0.69
C12:0	4.2	5.6	4.7	4.9	4.5	4.3	0.69	0.30	0.31	0.61
C14:0	186.0	204.9	179.5	184.0	180.1	184.3	0.34	0.28	0.73	11.40
C14:1	44.9	49.2	40.9	45.3	42.3	44.7	0.41	0.16	0.94	3.50
C15:0	32.9	32.6	29.5	29.4	31.4	29.5	0.23	0.63	0.88	2.12
C15:1[2]	40.4	49.6	51.0	43.4	45.7	45.0	0.76	0.90	**0.03**	3.48
C16:0	1,688.6	1,852.6	1,655.8	1,627.5	1,653.9	1,677.1	0.32	0.47	0.55	98.37
C16:1	240.5	271.1	241.9	254.2	251.6	260.3	0.81	0.13	0.70	15.12
C17:0	99.6	110.1	104.1	95.8	103.1	94.5	0.61	0.68	0.24	7.00
C17:1	94.9	102.5	98.8	85.8	89.1	85.1	0.21	0.55	0.29	7.10
C18:0	1,059.8	1,158.9	1,059.5	1,006.3	1,010.9	1,009.5	0.25	0.77	0.46	66.97
C18:1	2,892.9	3,209.6	2,886.7	2,801.2	2,876.4	2,973.1	0.41	0.39	0.44	169.91
C18:1v	114.0	124.1	115.9	115.9	100.6	104.1	0.16	0.54	0.86	9.98
C19:0	44.7	36.2	32.0	39.5	33.5	33.2	0.30	0.91	0.22	5.06
C18:2TT	273.3	252.7	267.2	255.9	272.1	238.7	0.93	0.20	0.87	23.96
C18:2[3]	230.4	239.5	298.7	252.8	223.8	225.1	0.04	0.49	0.37	23.02
C18:3ω3	11.4	15.4	15.6	15.0	14.1	14.0	0.25	0.24	0.10	1.35
C20:0	22.9	20.9	26.2	20.6	24.5	23.8	0.47	0.06	0.37	1.95
C20:1	26.0	26.0	24.2	23.6	22.0	27.8	0.70	0.41	0.31	2.83
C20:3ω6	14.0	15.2	14.5	14.3	14.9	13.5	0.91	0.84	0.35	1.03
C20:4ω6	41.1	42.1	43.2	41.9	43.0	41.3	0.91	0.73	0.83	2.44
C22:5	12.5	14.6	11.9	12.1	12.3	11.6	0.13	0.50	0.26	0.94
Total	7,106.7	7,749.5	7,092.9	6,894.2	7,000.8	7,059.2	0.41	0.57	0.49	387.66
Other	22.8	49.7	46.2	27.8	52.3	50.9	0.32	0.80	0.14	12.48
SFA	3,123.6	3,372.9	3,075.7	2,994.6	3,024.5	3,040.9	0.33	0.65	0.60	179.91
UFA	3,983.0	4,376.6	4,017.3	3,899.6	3,976.3	4,018.2	0.49	0.51	0.42	214.44
SFA: UFA	0.78	0.78	0.77	0.77	0.77	0.76	0.54	0.69	0.95	0.02
MUFA	3,433.6	3,817.9	3,429.8	3,358.8	3,419.3	3,505.8	0.44	0.38	0.46	199.74
PUFA	549.4	558.7	587.5	540.8	557.1	512.4	0.60	0.26	0.57	32.44
ω6	52.56	52.93	54.63	54.21	55.24	51.30	0.83	0.57	0.72	3.07
ω3	11.37	15.39	15.59	15.00	14.16	14.04	0.25	0.24	0.10	1.35
ω6:ω3	4.59	3.90	3.96	3.81	4.66	4.00	0.34	0.06	0.64	0.38

[1]Amount (mg/100 g tissue) of fatty acid in powdered loin sample determined by gas chromatography.

[2]For C15:1, mean separation for the pasture × finishing treatments did not differ ($\alpha = 0.05$).

[3]For C18:2, mean separation for the pasture phase is no supplement = 234.93[a,b], field pea = 275.71[a], and corn = 224.45[b] ($P = 0.04$). Means with different superscripts are different.

MUFA, monounsaturated fatty acid; PUFA = polyunsaturated fatty acid; SEM = standard error of the mean; SFA = saturated fatty acid; UFA = unsaturated fatty acid.

Proximate analysis

Neither backgrounding nor finishing diets had an effect ($P > 0.05$) on moisture (70.30%), protein (21.03%), fat (7.17%), or ash (1.49%) content in beef. Compared to other protein sources in animal diets, these results are in accordance with those reported by Domenech et al. (2014) in which cattle receiving several inclusion levels of full-fat or de-oiled Wet Distillers Grains plus Solubles had no differences in moisture, protein, fat, and ash content. Additionally, Mills et al. (1992) conducted an experiment feeding corn silage and alfalfa hay to Holstein and crossbred steers with varying levels of protein sources of either soybean meal or fish meal and observed no differences in proximate analysis of beef.

Fatty acid composition

Table 4 summarizes the fatty acid profile of all the dietary treatments reported on a basis of milligrams per 100 g of tissue. There was a significant interaction between pasture and finishing treatments for C15:1, but the range in values was relatively low, and no implications from these differences could be identified. Supplementing cattle on pasture with field peas resulted in more C18:2 fatty acids than when cattle were supplemented with corn, whereas beef from cattle without supplement had intermediate amounts. However, these differences did not carry over into total polyunsaturated fatty acid content and did not differ among finishing dietary treatments. In the current study, dietary treatment had no effect on total saturated, unsaturated, monounsaturated, or polyunsaturated fatty acid content ($P > 0.05$; Table 4). Although fatty acid composition for field peas has not been reported in beef, Scerra et al. (2011) have reported the composition of intramuscular fatty acids for lambs (Merinizzata Italiana) fed field peas (24% inclusion rate; fed for 90 d). Unlike the current study, Scerra et al. (2011) found an increase in linolenic acid (C18:3 n-3) and total n-3 polyunsaturated fatty acid content compared to lambs given faba bean or soybean meal, resulting in a decrease in the n-6/n-3 ratio. Furthermore, even with slight differences between the two studies, both studies concur that there are no negative impacts to meat quality associated with feeding field peas.

Conclusions

Overall, there were minimal to no effects on color, tenderness, and lipid oxidation associated with the use of field peas on fresh beef aged for 14 d. Although fatty acid composition has not been reported in beef for field peas, this study concludes that, in terms of fatty acid profiles, feeding field peas at 0.05% BW through the pasture phase increased C18:2 relative to a corn supplementation, yet this difference did not alter the overall polyunsaturated fatty acid content of beef. Additionally, feeding field peas during the finishing phase at 20% dry-matter basis had no effect on fatty acid composition. Thus, subtle differences in fatty acid composition were detected from various diet combinations of corn, field peas, and no supplements during the grazing and finishing phases of growth but did not extend to total saturated, unsaturated, monosaturated, or polyunsaturated fatty acid content and did not influence meat quality. In conclusion, these data indicate that field peas may be used as an alternative feedstuff for growing and finishing cattle with minimal to no negative impact on fresh beef quality.

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