Effect of Feeding Field Peas on Fresh Beef Quality

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Summary with Implications

This study was conducted over two years to evaluate the use of field peas during two phases of production (grazing and finishing) on overall fresh beef quality. The backgrounding treatments included: no supplement, field peas, or dry-rolled corn and finishing treatments included the presence or absence of field peas. Loin samples (n = 232) were aged for 14 d and placed under retail display conditions for 7 d. Dietary treatments had no effect on tenderness (WBSF or SSF) or visual discoloration and minimal effects on objective color, lipid oxidation and fatty acid composition. These data indicate field peas may be used as an alternative feed for growing and finishing cattle with minimal to no negative impact on fresh meat quality.

Introduction

Field peas have become a viable feed supplement for beef cattle. Field peas are an annual cool-season legume crop primarily produced in South Dakota, North Dakota and the western panhandle of Nebraska. They compare favorably with other grains for several nutrients including crude protein, starch and fat. However, the impact of feeding field peas on fresh meat quality has not been well studied. Therefore, this study was conducted to determine the effect of feeding field peas on shelf-life, tenderness, lipid oxidation, and fatty acid profiles of beef.

Procedure

A total of 232 crossbred cattle (replicated over 2 yrs; steers during year one, heifers during year 2) were subjected to one of three background treatments on crested wheatgrass pastures with either: 1) no supplement, 2) field peas at 0.5% BW, or 3) dry-rolled corn supplemented at 0.5% BW and one of two finishing treatments: 1) supplemented with field peas (20% on a DM basis) or 2) no peas were added to the diet. Each background treatment consisted of 4 replications with 10 hd per pasture for a total of 40 hd per treatment per year. A 3-inch thick slice of the anterior portion of the strip loin was collected at the 12/13th rib area from every side of every carcass. All samples were immediately fabricated and then aged for 14 days. Right loin samples were fabricated into ¾-inch thick steaks and 1-inch steaks. The ¾-inch steak was used for laboratory analysis of fatty acid composition while the 1-inch steak was used for tenderness measurement [Warner-Bratzler Shear Force (WBSF) and Slice Shear Force (SSF)] for day 0 of retail display. Left loin samples were fabricated into ½-inch thick steaks and 1-inch steaks. The ½-inch steak was used to measure lipid oxidation while the 1-inch steak was used for visual discoloration and tenderness measurements for day 7 of retail display.

Tenderness—Warner-Bratzler Shear Force (WBSF) & Slice Shear Force (SSF)

For all steaks (never frozen), an internal raw temperature and weight were recorded. Steaks were cooked to a target temperature of 160°F on a Belt Grill (TBG60-V3 MagiGril, MagiKitch'n Inc., Quakertown, PA). After cooking, an internal temperature and weight were recorded and slice shear force evaluation was conducted using a Food Texture Analyzer with a Slice Shear Force blade. The remainder of the steak was individually bagged and stored in a cooler (maintained at 33°F). Approximately 24 hours after SSF evaluation was conducted, six cores (1/2-inch 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.

Subjective Discoloration (Visual Discoloration)

Percent discoloration was estimated daily for seven days by six graduate students during the first year and eight graduate students during the second year, all of whom had previous experience with subjective color scoring.

Objective Color (L, a*, b* values)*

During retail display, objective color was assessed daily with a Minolta Colorimeter (CR-400, Minolta Camera Company, Osaka, Japan). The D65 illuminant setting and 2° observer were used with an 8 mm diameter measurement area. The colorimeter was calibrated daily 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).

Lipid Oxidation (TBARS)

Frozen samples (from retail display days 0, 4 and 7) were diced into small pieces, with no subcutaneous fat, and flash frozen in liquid nitrogen. The frozen pieces were homogenized in a Waring commercial blender and a 5 g sample was weighed in duplicate to conduct the TBARS protocol.

Fatty Acid Profile

Frozen samples, with no subcutaneous fat, were diced into small pieces and flash frozen in liquid nitrogen. Samples were then homogenized in a Waring commer-

Table 1. Amount[1] of fatty acids of beef from cattle fed corn, field peas or no supplement (*L. dorsi*)

	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*[2]
C10:0	3.97	5.11	5.40	5.11	4.41	4.45	0.28	0.52	0.44	0.69
C12:0	4.20	5.56	4.70	4.87	4.53	4.35	0.69	0.30	0.31	0.61
C14:0	185.96	204.88	179.51	184.02	180.12	184.34	0.34	0.28	0.73	11.40
C14:1	44.88	49.22	40.92	45.31	42.25	44.67	0.41	0.16	0.94	3.50
C15:0	32.89	32.62	29.51	29.41	31.40	29.48	0.23	0.63	0.88	2.12
C15:1	40.40	49.64	51.02	43.43	45.72	45.02	0.76	0.90	0.03	3.48
C16:0	1,688.57	1,852.63	1,655.76	1,627.45	1,653.85	1,677.08	0.32	0.47	0.55	98.37
C16:1	240.45	271.14	241.89	254.20	251.59	260.25	0.81	0.13	0.70	15.12
C17:0	99.61	110.05	104.09	95.75	103.14	94.50	0.61	0.68	0.24	7.00
C17:1	94.98	102.52	98.79	85.78	89.13	85.12	0.21	0.55	0.29	7.10
C18:0	1,059.83	1,158.86	1,059.53	1,006.33	1,010.95	1,009.54	0.25	0.77	0.46	66.97
C18:1	2,892.93	3,209.57	2,886.72	2,801.20	2,876.43	2,973.08	0.41	0.39	0.44	169.91
C18:1v	114.01	124.05	115.85	115.97	100.62	104.09	0.16	0.54	0.86	9.98
C19:0	44.65	36.22	32.02	39.54	33.51	33.20	0.30	0.91	0.22	5.06
C18:2TT	273.28	252.67	267.17	255.87	272.13	238.71	0.93	0.20	0.87	23.96
C18:2	230.40	239.45	298.65	252.77	223.82	225.08	0.04[a]	0.49	0.37	23.02
C18:3ω3	11.37	15.39	15.59	15.00	14.16	14.04	0.25	0.24	0.10	1.35
C20:0	22.94	20.97	26.18	20.64	24.52	23.83	0.47	0.06	0.37	1.95
C20:1	26.04	26.02	24.20	23.55	22.01	27.76	0.70	0.41	0.31	2.83
C20:3ω6	14.01	15.24	14.47	14.28	14.96	13.46	0.91	0.84	0.35	1.03
C20:4ω6	41.11	42.05	43.15	41.96	43.01	41.34	0.91	0.73	0.83	2.44
C22:5	12.45	14.57	11.98	12.07	12.28	11.56	0.13	0.50	0.26	0.94
Total	7,106.65	7,749.47	7,092.94	6,894.24	7,000.84	7,059.18	0.41	0.57	0.49	387.66
Other	22.77	49.72	46.15	27.79	52.25	50.93	0.32	0.80	0.14	12.48
SFA[2]	3,123.64	3,372.91	3,075.65	2,994.65	3,024.53	3,040.94	0.33	0.65	0.60	179.91
UFA[2]	3,983.02	4,376.57	4,017.30	3,899.59	3,976.32	4,018.24	0.49	0.51	0.42	214.44
SFA:UFA[2]	0.78	0.78	0.77	0.77	0.77	0.76	0.54	0.69	0.95	0.02
MUFA[2]	3,433.64	3,817.86	3,429.83	3,358.83	3,419.25	3,505.81	0.44	0.38	0.46	199.74
PUFA[2]	549.38	558.70	587.47	540.77	557.07	512.43	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]SEM = Standard Error of the Mean, SFA = Saturated fatty acids, UFA= Unsaturated fatty acids, SFA:UFA = Saturated fatty acids: Unsaturated fatty acids, MUFA= Monounsaturated fatty acids, and PUFA=Polyunsaturated fatty acids
[a]For C18:2, peas on pasture treatment were higher than the corn on pasture ($P = 0.04$), no supplement on pasture was not different to peas or corn on pasture.

cial blender and a 1 g sample was weighed out to conduct fatty acid determination via gas chromatography. Total fatty acids converted to methyl esters were separated on a fused silica column (Chromopack CP-Sil; 0.25mm x 100m) which was placed in an oven programmed from 284°F for 10 min to 428°F at a rate of 35°F/min and held at 428°F for 20 min. Total run time was 70 min. The injector and detector were programmed to work at 518°F and 572°F, respectively. Each lipid extract was separated into fatty acids by using helium as the carrier gas at a flow rate of 1mL/min. Individual fatty acids of each sample were determined by comparison of retention times with known standards and the percent of fatty acid was determined by the peak area in the chromatograph.

Statistical Analysis

This study was conducted with a treatment design of a 3 x 2 factorial (backgrounding diet x finishing diet) and analyzed using SAS® 9.4 package, SAS Institute, Inc., USA. Objective color and percent discoloration were analyzed for treatment main effects using the PROC GLIMMIX procedure of SAS with day as repeated measures when traits were measured over time. All other analyses were conducted with PROC GLIMMIX as well; all means were separated with the LS MEANS statement and TUKEY adjustment with an alpha level of 0.05 and tendencies were considered at an alpha level of 0.1.

Results

In general, there were minimal effects due to diet. Tenderness (measured with WBSF and SSF) only presented differences due to retail display, showing an increase in tenderness with days of retail display ($P < 0.0001$). Neither backgrounding, nor finishing treatment influenced tenderness measurements. A strong correlation between WBSF and SSF was observed (r = 0.65; $P = < 0.0001$).

Discoloration, L* and a* had triple interactions of retail display, by pasture, by finishing diets ($P < 0.0001$, p=0.0524 and p=0.024, respectively). In general, samples placed under retail display did not exhibit meaningful discoloration as samples only reached 1.47% discoloration by d 7 irrespective of dietary treatment during both combined years. Although these interactions were statistically significant, no consistent patterns due to treatments could be identified. Similarly, the magnitude of difference would require extended aging periods to visually influence the color differences perceived by consumers.

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; $P = 0.0541$), although this is not a meaningful difference. As expected, lipid oxidation increased over time of simulated retail display (0d = 0.94, 4d = 1.46 and 7d = 2.11 mg malonaldehyde/kg tissue; $P < 0.0001$).

Dietary treatment had no effect on content of saturated fatty acids, unsaturated fatty acids, monounsaturated fatty acids or polyunsaturated fatty acids ($P > 0.05$; Table 1). There was a significant interaction between pasture and finishing treatments for C15:1 but the range in values was relative low and no implications from these differences could be identified. Supplementing cattle on pasture with field peas resulted in significantly more C18:2 fatty acids than when cattle were supplemented with corn, while cattle without supplement were intermediate. However, these differences did not carry over into total PUFA content, and differences among treatments could not be identified. Thus, subtle differences in fatty acid composition that occurred from the treatments did not influence meat quality.

Overall, there were minimal changes in discoloration, color, or tenderness. In conclusion, these data indicate field peas may be used as an alternative diet for growing and finishing cattle with minimal to no negative impact on fresh meat quality.

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