Effects of graded levels of potato by-products in barley- and corn-based beef feedlot diets: II. Palatability[1]

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ABSTRACT: The objective of this study was to evaluate the effects of barley- or corn-based diets containing 0, 10, or 20% potato by-product (DM basis) on Warner-Bratzler shear force and palatability of beef. One hundred forty-four crossbred beef steers (333 ± .44 kg) were allotted within weight block (3) to a randomized complete block design with a 2 × 3 factorial arrangement of dietary treatments. Main effects were grain (barley or corn) and level of potato by-product (0, 10, or 20% of diet DM). There were a total of 18 pens with eight steers per pen and three pens per treatment. Steers were fed diets containing 83% concentrate (grain plus potato by-product), 10% supplement, and 7% alfalfa (DM basis) for an average of 130 d. Longissimus muscle cuts were used for Warner-Bratzler shear force determination (four steers per pen) and evaluation (two steers per pen) by a 10-member trained laboratory panel, a professional flavor/texture profile panel, and by consumer panels. Diet did not affect ($P > .10$) Warner-Bratzler shear force or trained laboratory panel tenderness, juiciness, and flavor intensity scores. Flavor/texture profile panel scores indicated feeding a corn-based diet as opposed to barley-based diet produced a more appropriate well-balanced and well-blended beef flavor and texture. However, the magnitudes of the differences were relatively small, and flavor and texture amplitude ratings for both barley- and corn-fed beef were well above average. Beef from steers fed 10 or 20% potato by-product had lower ($P < .05$) incidences of inappropriate aromatics and aftertastes, which may have a slightly beneficial effect on beef flavor, but flavor amplitude was not affected ($P > .05$) by level of potato. Moreover, consumer panel overall acceptability scores were not affected by diet. Thus, feedlot diets containing corn or barley with or without potato by-product should result in palatable beef products.

Key Words: Barley, Beef, Corn, Palatability, Potato

 J. Anim. Sci. 2000. 78:1837–1844

Introduction

Inclusion of potato by-products (**PB**) at up to 51.9% of DM in barley-based diets did not affect ADG, feed efficiency, or carcass characteristics (Heinemann and Dyer, 1972; Heinemann et al., 1978a,b), and these products are routinely included in feedlot diets in parts of North America. Some meat retailers, purveyors, and chefs in North America and Japan, however, believe barley/potato-fed beef is softer, more watery, inferior in color, tougher, and less flavorful than corn-fed beef, which limits marketing options for barley/potato-fed beef. Our companion paper (Nelson et al., 2000) showed that type of grain (barley vs corn) and level of PB had little impact on beef color, firmness, wateriness, or purge. Miller et al. (1996) reported that palatability attributes and Warner-Bratzler shear force (**WBS**) did not differ between steaks from steers fed corn-based and those fed barley-based diets. Jeremiah et al. (1998) also concluded that source of dietary grain (corn vs barley) produced no important effects on the beef cooking properties and palatability, but beef from animals fed barley-based diets was slightly inferior to beef from animals fed corn-based diets in certain flavor attributes. The effects of feeding PB on beef palatability attributes are unknown. Therefore, the objective of this study was to determine effects of barley- or corn-based

[1]This work was supported by the Agric. Res. Ctr., College of Agric. and Home Econ., Washington State Univ. Pullman 99164 (Projects 0304 and 0213) and by the Washington Barley Commission, Spokane, Washington Beef Commission, Seattle, and the Washington Cattle Feeders Assoc., Pasco.

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Received July 23, 1999.
Accepted January 13, 2000.

diets containing 0, 10, or 20% PB (dry matter basis) on beef palatability.

Materials and Methods

Animals and Feeding. One hundred forty-four crossbred beef steers (333 ± .44 kg) were allotted within weight block (3) to a randomized complete block design with a 2 × 3 factorial arrangement of dietary treatments. Main effects were grain (barley or corn) and level of potato by-product (0, 10, or 20% of diet DM). There were a total of 18 pens with eight steers per pen and three pens per treatment. All diets provided 417 IU vitamin E/d. Animals, diets, and feeding regimen are described in detail in Nelson et al. (2000). Steers were slaughtered by block. The heaviest block was slaughtered after 120 d, the middle block after 130 d, and the lightest after 140 d on feed. Steers were shipped 320 km from the Washington State University Cattle Feeding Laboratory to a commercial plant where they were humanely slaughtered the day of shipping.

Muscle Sampling. Carcasses were chilled for 24 h at –1 to 0°C, and then a boneless strip loin roast was removed from the left side of four randomly selected carcasses per pen (72 total), vacuum-packaged, and transported to Washington State University as described by Nelson et al. (2000). Loins were aged at 1°C until 14 d postmortem. After aging, vacuum packages were opened, strip loins were trimmed to less than .2 cm of fat, and beginning at the 13th rib (anterior end) of the strip, two 2.5-cm steaks were sliced. The first was used for WBS determination and the second for evaluation by a trained laboratory sensory panel. A 4.4-cm section was then removed for analyses reported in Nelson et al. (2000) and for two randomly selected steers per pen (six per treatment) the remainder of the strip loin (a 7.5- to 12-cm roast) was used for flavor/texture profile panel evaluation. Roast samples from the other two steers per pen were sliced into 2.5-cm steaks, and steaks within a pen were pooled, vacuum-packaged, and immediately frozen at –40°C for evaluation within 11 mo by consumer panels. Samples for WBS, trained laboratory sensory panel, and flavor/texture profile panel were vacuum-packaged and immediately frozen at –40°C for evaluation within 3 mo.

Warner-Bratzler Shear Force Determination. Steaks were thawed for 30 h at 2°C prior to cooking. Thaw-drip loss was determined. Samples were cooked to an internal temperature of 71°C (AMSA, 1995) as monitored by a Digi-Sense scanning thermocouple thermometer (Model 692-8010, Barnart Co., Barrington, IL), cooled to room temperature, and percentage cooking loss was determined. Six 1.27-cm cores from each steak were obtained parallel to the muscle fibers. Cores were sheared once through the center on a TA-XT2 Texture Analyzer (Texture Technologies, Scarsdale, NY) equipped with a WBS attachment at a crosshead speed of 20 cm/min.

Trained Laboratory Panel. Steaks from two randomly selected steers per pen were thawed and cooked as described for WBS. After cooking, external fat and major connective tissue were removed. Steaks were cut into 1- × 1- × 2.5-cm cubes, degree of doneness was determined using the Beef Steak Color Guide (AMSA, 1979), and samples were served immediately to a 10-member trained sensory panel (AMSA, 1995). The sensory panel scored samples for tenderness, juiciness, flavor intensity, and off-flavor by placing marks on 10-cm lines labeled at each end. A ruler was used to determine the panelists' scores, with 0 = extremely tough, dry, bland, and no off-flavor and 10 = extremely tender, juicy, intense beef flavor, and pronounced off-flavor.

Flavor/Texture Profile Panel. Roasts from the same steers used for the trained laboratory panel (two steers per pen) were transferred frozen to the Lacombe Research Centre (Lacombe, AB, Canada) for flavor/texture profile analysis (Jeremiah et al., 1997). Upon removal from the freezer, roasts were thawed at 4°C for 48 h. Thaw-drip loss was measured. Roasts were cooked to an internal temperature of 72°C in an electric convection oven preheated to 177°C. Total cooking loss and cooking time were determined. Roasts were subsampled by cutting them into cubes (1.9 × 1.9 × 1.9 cm) which were placed in covered glass containers in a circulating (70°C) water bath. Cubes were allowed to equilibrate in temperature for 7 min prior to evaluation by a highly trained, experienced, professional, flavor/texture profile panel (at least six members), screened and trained according to Jeremiah et al. (1997). Panel sessions were conducted in environmentally controlled, partitioned booths under 580 lx of green incandescent light. Room-temperature distilled water and unsalted soda crackers were provided to cleanse the palate between sample evaluations.

Consumer Panels. Steaks from steers fed the barley or corn diets containing 0 or 20% PB were evaluated by consumer panelists at two locations, the Washington Cattle Feeder's Convention (Lake Chelan, WA) and the Washington Cattlemen's Convention (Ocean Shores, WA). Panelists consisted primarily of cattle producers, feeders, educators, media persons, and agricultural product suppliers, and there were approximately equal numbers of male and female panelists. At each location three sets of four samples were served to the panelists. Sets were the weight blocks of the steers and all four treatments were represented in each set. The same 12 samples were evaluated at both locations. Steaks were thawed for 30 h at 2 to 4°C and then cooked on commercial gas grills to a medium degree of doneness as determined by the convention center chefs and confirmed by a trained meat scientist using the Beef Steak Color Guide (AMSA, 1979). All subcutaneous fat and epimysium were removed and steaks were cut into a 1- × 1- × 2.5-cm cubes. One sample from each of the four dietary treatments, within a weight block, was placed on each plate. Samples were identified with a randomly selected three-digit number. Panelists rated each sample for overall acceptability on a verbally anchored hedonic scale with nine categories. At each location each set of four samples was evaluated by 40 to 60 panelists. Panelist scores for each sample were averaged at each location.

Statistical Analysis. Cooking attributes, WBS, and trained laboratory panel data were analyzed as a randomized complete block design with a 2 × 3 factorial arrangement of dietary treatments (Steel and Torrie, 1980). The model included grain, PB level, grain × PB, weight block, and grain × PB × weight block. The model for trained laboratory panel data also included degree of doneness as a covariate. Grain × PB level × weight block was used as the error term for testing grain, PB level, and grain × PB level. Linear and quadratic effects of level of PB were calculated (Steel and Torrie, 1980). Profile panel data denoting intensity of specific flavor and texture character notes, amplitude ratings, and order of appearance of specific flavor character notes were analyzed using a model that included grain, PB level, and grain × PB level using animal within dietary treatment as the error term. Linear and quadratic effects of level of PB were calculated. Profile data denoting the proportions of samples displaying certain flavor and texture properties in the various treatment comparisons were analyzed using the chi-square test (Puri and Mullen, 1980). Consumer panel data were analyzed as a randomized complete block design with two locations (blocks) and three replicates (weight blocks). Data were analyzed using the GLM procedure of SAS (1988).

Results and Discussion

Warner-Bratzler Shear Values and Trained Laboratory Panel

Type of grain, level of PB, and the grain × PB interaction did not affect ($P > .10$) thaw-drip loss, cooking attributes, WBS values, or trained laboratory sensory panel tenderness, juiciness, beef flavor intensity, and off-flavor scores (Table 1). Linear and quadratic effects of level of PB on these cooking and palatability attributes were also not significant ($P > .05$). These results support the findings of Miller et al. (1996), who reported WBS values and descriptive palatability attributes did not differ among steaks from steers fed barley-, barley/corn-, or corn-based diets. Jeremiah et al. (1998) also reported no difference in semitrained laboratory scores for tenderness, juiciness, beef flavor intensity, flavor desirability and overall acceptability between steaks from steers fed barley- or corn-based diets. The effects of dietary PB on beef palatability have not been previously evaluated. These results showed that, contrary to the perceptions of some beef purveyors and chefs, WBS and trained laboratory panel sensory scores were not affected by level of PB in steer diets.

Flavor/Texture Profile Panel

Type of grain, level of PB, and the grain × PB interaction did not affect ($P > .10$) cooking loss (27.6 ± .35%) or cooking time (7.83 ± .134 min/100 g) for roasts prepared for the flavor/texture profile panel (data not shown). These results, combined with the thaw-drip loss and cooking attributes of steaks broiled for WBS, confirm those reported in our companion paper (Nelson et al., 2000) indicating neither type of grain nor level of PB affected wateriness or moisture retention properties of beef. Miller et al. (1996) and Jeremiah et al. (1998) also reported that type of grain did not affect cooking attributes of steaks and roasts, respectively.

Grain Effects on Texture and Flavor Profiles. Roast samples from steers fed corn-based diets had more surface fat, were easier to swallow, and had a lower proportion of medium fibers during mastication ($P < .05$) than

Table 1. Thaw-drip loss, cooking loss, Warner-Bratzler shear values, and trained sensory panel scores of beef longissimus muscle steaks from steers fed barley- or corn-based diets with 0, 10, or 20% potato by-product (PB)

			Probability of a greater F-value for effect of				
Variable	Overall mean	SE[a]	Grain source	Level of PB	Linear effect of PB	Quadratic effect of PB	Grain × PB
Number[b]	18	—	—	—	—	—	—
Thaw-drip loss, %	2.07	.069	.742	.775	.917	.491	.312
Cooking loss, %	25.7	.48	.942	.192	.515	.093	.122
Cooking time, min/100 g	5.63	.136	.778	.618	.604	.414	.214
Shear force, kg	3.49	.098	.356	.308	.939	.134	.613
Sensory panel scores[c]							
Tenderness	6.50	.132	.822	.119	.273	.119	.518
Juiciness	5.84	.123	.526	.511	.305	.794	.135
Flavor intensity	6.00	.085	.662	.160	.072	.891	.822
Off-flavor	.37	.057	.996	.611	.354	.630	.968

[a]Grain × potato by-product level × weight block was used as the error term.
[b]Pen served as the experimental unit. Steaks from four animals per pen (72 total) were evaluated for thaw-drip loss, cooking loss, cooking time, and shear force, and the sensory panel evaluated steaks from two animals per pen (36 total).
[c]Panelist scores: 0 = extremely tough, dry, bland, and no off-flavor; 10 = extremely tender, juicy, intense beef flavor, and pronounced off-flavor.

Table 2. Texture profiles for longissimus muscle roasts from cattle fed barley- or corn-based diets with potato by-products

Item	Barley	Corn	Se[a]
Number	18	18	—
Surface properties			
Smoothness	6.86	6.97	.13
Surface moisture	2.60	2.91	.18
Fat amount	1.00[y]	1.29[x]	.08
Fat type[b]: A, %	100.0	100.0	—
Particle amount	2.53	2.43	.15
Partial compression properties			
Elasticity	5.73	5.63	.10
First bite properties			
Compressibility	6.09	5.90	.09
Moisture release	2.52	2.77	.14
Fat amount	1.32	1.42	.07
Fat type[b]: A, %	100.0	100.0	—
Cohesiveness	6.61	6.52	.10
Mastication properties			
Number of chews	31.4	30.8	.66
Chewiness	8.25	8.15	.18
Rate of breakdown	8.75	8.92	.18
Fibreousness	7.30	7.18	.07
Fiber type[c]			
A, %	66.7	83.3	—
B, %	33.3[x]	16.7[y]	—
Moisture release	2.59	2.87	.13
Moisture absorption	7.52	7.23	.13
Cohesiveness	6.84	6.71	.11
Fat amount	1.18	1.33	.07
Fat type[b]: A, %	100.0	100.0	—
Uniformity	10.07	10.15	.09
Density	8.48	8.25	.11
Connective tissue amount	7.22	7.22	.09
Connective tissue type[d]			
A, %	5.6[y]	16.7[x]	—
B, %	16.7[x]	.0[y]	—
C, %	77.8	83.3	—
Particle type[c]			
A, %	5.6[y]	16.7[x]	—
B, %	94.4	83.3	—
Afterfeeling properties			
Ease of swallowing	9.91[y]	10.21[x]	.08
Fat amount	1.11	1.29	.08
Fat type[b]: A, %	100.0	100.0	—
Particle amount	2.56	2.51	.09
Particle type[e]			
A, %	66.7	61.1	—
B, %	22.2	33.3	—
C, %	11.1	5.6	—
Mouthcoating amount	3.64	3.75	.06
Mouthcoating type[f]: A, %	100.0	100.0	—
Toothpacking	2.17	2.12	.05
Amplitude	8.87[y]	9.64[x]	.16

[a]Animal within dietary treatment was used as the error term.
[b]Fat type: A = greasy; B = oily; C = greasy and oily.
[c]Fiber type: A = fine plus; B = medium.
[d]Connective tissue type: A = webbed fibers; B = webbed fibers and hard gristle; C = webbed fibers and soft gristle.
[e]Particle type: A = grainy, mealy, mushy, crumbly, and stringy; B = grainy, mealy, mushy, crumbly, stringy, and gristle; C = grainy, mealy, mushy, and crumbly.
[f]Mouthcoating type: A = particle and grease.
[x,y]Within a row, means lacking a common superscript letter differ ($P < .05$).

samples from barley-fed steers (Table 2). They also had a higher proportion of connective tissue described as being “webbed fibers” and a lower proportion of connective tissue described as being “webbed fibers and hard gristle” than samples from steers fed barley-based diets ($P < .05$). Consequently, samples from steers fed corn-based diets received higher ($P < .05$) texture amplitude scores, indicating they had a more appropriate, well-balanced, and well-blended texture than samples from steers fed barley-based diets, but amplitude scores for both grain sources were well above average (7.5 is average on this 15-point scale).

Roast samples from steers fed barley-based diets displayed a higher incidence of an inappropriate metallic aromatic and aftertaste ($P < .05$, Table 3) than samples from steers fed corn-based diets. In addition, samples from steers fed corn-based diets had a higher ($P < .05$) intensity of an appropriate browned aftertaste than samples from steers fed barley-based diets. These differences combined to give samples from animals fed corn-based diets a slightly higher ($P < .05$) flavor amplitude (the appropriateness, balance, and blend of the overall flavor) than samples from animals fed barley-based diets. Jeremiah et al. (1998) also reported that roasts from steers fed barley-based diets had a higher incidence of metallic aftertaste, but in that study grain source (barley or corn) did not significantly affect flavor amplitude. In the present study, the flavor amplitude scores for roasts from both barley- and corn-fed steers (8.39 and 8.86) were relatively high (7.5 is average).

Potato By-product Level Effects on Texture and Flavor Profiles. The amount of fat detected during mastication was affected ($P < .05$) linearly by level of PB, with samples from steers receiving no PB having the most (Table 4). Roast samples from steers fed 10 and 20% PB had higher proportions of an inappropriate connective tissue described as being “webbed fibers and hard gristle” ($P < .05$) than samples from steers receiving no PB.

Table 3. Flavor profiles for longissimus muscle roasts from cattle fed barley- or corn-based diets with potato by-products

	Incidence		Intensity			Order of appearance		
Item	Barley	Corn	Barley	Corn	SE[a]	Barley	Corn	SE[a]
Number	18	18	18	18	—	18	18	—
Aromatics								
Beefy[b]	100.0	100.0	6.67	6.90	.10	1.00	1.00	.00
Off	94.4	100.0	1.36	1.35	.17	1.00	1.00	.00
Barny	27.8	16.7	1.50	1.18	.25	1.00	1.00	.00
Sour/off	55.6	44.4	.50	.34	.08	1.04	1.50	.16
Browned[b]	100.0	100.0	1.58	1.84	.12	2.00	1.72	.11
Fatty[b]	100.0	100.0	1.40	1.52	.08	2.94	2.94	.08
Livery	100.0	100.0	1.21	1.02	.13	2.22	2.50	.14
Bloody	44.4	27.8	.47	.45	.14	2.91	2.57	.32
Metallic	33.3[x]	5.6[y]	.33	.37	.08	5.30	2.30	1.42
Tastes								
Sweet[b]	100.0	100.0	2.36	2.47	.05	3.00	3.00	.00
Salt[b]	100.0	100.0	1.65	1.70	.03	4.00	4.00	.00
Sour[b]	100.0	100.0	2.41	2.40	.07	4.72	4.89	.13
Bitter	83.3	77.8	.52	.51	.08	5.62	5.23	.21
Mouthfeelings								
Temperature[b]	100.0	100.0	8.05	8.12	.04	2.00	2.00	.00
Astringent	100.0	100.0	2.26	2.21	.06	4.00	4.00	.00
Aftertaste/afterfeelings								
Beefy[b]	100.0	100.0	5.62	5.77	.08			
Sweet[b]	100.0	100.0	1.63	1.72	.04			
Salt[b]	100.0	100.0	1.01	.99	.02			
Sour[b]	100.0	100.0	1.68	1.62	.09			
Bitter	94.4	94.4	.58	.55	.08			
Browned[b]	100.0	100.0	.70[b]	.91[x]	.07			
Fatty[b]	88.9	100.0	.91	.95	.07			
Off	38.9	55.6	.33	.33	.08			
Barny	5.6	5.6	.50	.43	.00			
Sour/off	11.1	27.8	.35	.23	.08			
Livery	100.0	88.9	.59	.61	.08			
Astringent	100.0	100.0	2.16	2.12	.05			
Bloody	33.3	22.2	.24	.27	.04			
Metallic	61.1[x]	33.3[y]	.43	.33	.07			
Amplitude	—	—	8.39[y]	8.86[x]	.15			

[a]Animal within dietary treatment was used as the error term.
[b]Appropriate flavor character note.
[x,y]Within a row and trait group, means lacking a common superscript letter differ ($P < .05$).

Table 4. Texture profiles for longissimus muscle roasts from cattle fed barley- or corn-based diets containing 0, 10, or 20% potato by-product

	Potato by-product, % DM			
Item	0	10	20	SE[a]
Number	12	12	12	—
Surface properties				
Smoothness	7.02	6.87	6.86	.16
Surface moisture	2.99	2.54	2.74	.22
Fat amount	1.21	1.12	1.11	.10
Fat type[b]: A, %	100.0	100.0	100.0	—
Particle amount	2.31	2.49	2.64	.18
Partial compression properties				
Elasticity	5.60	5.69	5.76	.12
First bite properties				
Compressibility	5.95	5.99	6.03	.12
Moisture release	2.72	2.66	2.55	.17
Fat amount	1.42	1.40	1.29	.09
Fat type[b]: A, %	100.0	100.0	100.0	—
Cohesiveness	6.51	6.58	6.60	.12
Mastication properties				
Number of chews	31.0	31.7	30.8	.81
Chewiness	8.04	8.35	8.22	.22
Rate of breakdown	8.96	8.66	8.87	.22
Fibrousness	7.20	7.32	7.22	.08
Fiber type[c]				
A, %	83.3	66.7	75.0	—
B, %	16.7	33.3	25.0	—
Moisture release	7.20	7.32	7.22	.16
Moisture absorption	7.12	7.50	7.51	.16
Cohesiveness	6.64	6.91	6.76	.13
Fat amount[v]	1.38	1.27	1.12	.08
Fat type[b]: A, %	100.0	100.0	100.0	—
Uniformity	10.01	10.07	10.25	.11
Density	8.29	8.39	8.42	.14
Connective tissue amount	7.10	7.39	7.17	.11
Connective tissue type[d]				
A, %	8.3[y]	.0[z]	25.0[x]	—
B, %	.0[y]	16.7[x]	8.3[x]	—
C, %	91.7[x]	83.3[xy]	66.7[y]	—
Particle type				
A, %	8.3[y]	.0[z]	25.0[x]	—
B, %	91.7	100.0	75.0	—
Afterfeeling properties				
Ease of swallowing[w]	10.19	9.90	10.09	.10
Fat amount	1.26	1.16	1.19	.10
Fat type[b]: A, %	100.0	100.0	100.0	—
Particle amount	2.45	2.54	2.63	.11
Particle type[c]				
A, %	66.7[x,y]	75.0[x]	50.0[y]	—
B, %	25.0	25.0	33.3	—
C, %	8.3[x]	.0[y]	16.7[x]	—
Mouthcoating amount	3.65	3.73	3.70	.07
Mouthcoating type[f]: A, %	100.0	100.0	100.0	—
Toothpacking	2.06	2.21	2.16	.06
Amplitude	9.32	9.06	9.38	.20

[a]Animal within dietary treatment was used as the error term.
[b]Fat type: A = greasy; B = oily; C = greasy and oily.
[c]Fiber type: A = fine plus; B = medium.
[d] Connective tissue type: A = webbed fibers; B = webbed fibers and hard gristle; C = webbed fibers and soft gristle.
[e]Particle type: A = grainy, mealy, mushy, crumbly, and stringy; B = grainy, mealy, mushy, crumbly, stringy, and gristle; C = grainy, mealy, mushy, and crumbly.
[f]Mouthcoating type: A = particles and grease.
[v]Linear effect of potato by-product ($P < .05$).
[w]Quadratic effect of potato by-product ($P < .05$).
[x,y,z]Within a row, means lacking a common superscript letter differ ($P < .05$).

Also, during mastication, samples from steers fed 20% PB had a higher proportion of connective tissue described as being “webbed fibers” and an appropriate particle type described as “grainy, mealy, mushy, crumbly, and stringy” ($P < .05$) than samples from steers fed no PB, which in turn had a higher proportion ($P < .05$) of this connective tissue and particle type than samples from steers fed 10% PB. Ease of swallowing was affected ($P < .05$) quadratically, with samples from steers fed 10% PB being the most difficult to swallow. However, this effect, though statistically significant, was quite small (range of .29 on a 15-point scale) and the means for all treatments were above average. Samples from steers receiving 0% or 20% PB had higher proportions of an appropriate residual particle type described as “grainy, mealy mushy, and crumbly” than samples from steers receiving 10% PB. Samples from steers fed 10% PB had a higher proportion of an appropriate particle type described as "grainy, mealy, mushy, crumbly, and stringy” than samples from steers receiving 20 % PB ($P < .05$). However, these differences were not of sufficient magnitude to influence texture amplitude.

Roast samples from steers fed no PB had a higher ($P < .05$) incidence of an inappropriate sour/off aromatic and aftertaste than samples from animals receiving 10 and 20% PB (Table 5). In addition, samples from steers fed no PB had a higher ($P < .05$) incidence of an inappropriate bloody aromatic and aftertaste than samples from steers fed 10% PB. A higher incidence of an inappropriate metallic aromatic was detected in samples from steers fed no PB than from steers fed 20% PB, which in turn displayed a higher incidence of this inappropriate aromatic than samples from animals receiving 10% PB ($P < .05$). Samples from animals fed 0% or 20% PB exhibited a higher incidence of an inappropriate metallic aftertaste than their counterparts from

Table 5. Flavor profiles for longissimus roasts from cattle fed barley- or corn-based diets containing 0, 10, or 20% potato by-product

	Incidence			Intensity				Order of appearance			
Item	0%	10%	20%	0%	10%	20%	SE[a]	0%	10%	20%	SE[a]
Number	12	12	12	12	12	12	—	12	12	12	—
Aromatic											
Beefy[b]	100.0	100.0	100.0	6.74	6.68	6.92	.12	1.00	1.00	1.00	.00
Off	100.0	100.0	91.7	1.45	1.37	1.25	.20	1.00	1.00	1.00	.00
Barny	16.7	25.0	25.0	1.38	1.27	1.37	.36	1.00	1.00	1.00	.00
Sour/off	75.0^{x}	33.3^{y}	41.7^{y}	.47	.33	.45	.09	1.41	1.25	1.15	.19
Browned[b]	100.0	100.0	100.0	1.56	1.83	1.74	.15	2.00	1.83	1.75	.14
Fatty[bv]	100.0	100.0	100.0	1.62	1.42	1.33	.09	2.92	3.00	2.92	.10
Livery	100.0	100.0	100.0	1.28	1.01	1.06	.16	2.42	2.25	2.42	.17
Bloody	50.0^{x}	25.0^{y}	33.3^{xy}	.69	.29	.40	.17	2.61	2.61	3.00	.39
Metallic	41.7^{x}	$.0^{z}$	16.7^{y}	.38	—	.31	.07	3.10	—	4.50	1.18
Tastes											
Sweet[bw]	100.0	100.0	100.0	2.33	2.54	2.37	.06	3.00	3.00	3.00	.00
Salt[b]	100.0	100.0	100.0	1.68	1.68	1.66	.04	4.00	4.00	4.00	.00
Sour[bv]	100.0	100.0	100.0	2.58	2.31	2.33	.08	4.58	4.83	5.00	.16
Bitter	100.0^{x}	58.3^{y}	83.3^{x}	.59	.45	.49	.10	5.83	5.17	5.26	.25
Mouthfeelings											
Temperature[b]	100.0	100.0	100.0	8.15	8.03	8.09	.05	2.00	2.00	2.00	.00
Astringent	100.0	100.0	100.0	2.23	2.27	2.20	.08	4.00	4.00	4.00	.00
Aftertastes/Afterfeelings											
Beefy[b]	100.0	100.0	100.0	5.64	5.72	5.71	.10				
Sweet[bw]	100.0	100.0	100.0	1.59	1.76	1.67	.05				
Salt[bv]	100.0	100.0	100.0	.96	1.02	1.03	.02				
Sour[b]	100.0	100.0	100.0	1.85	1.56	1.54	.11				
Bitter	100.0	91.7	91.7	.66	.47	.56	.10				
Browned[b]	100.0	100.0	100.0	.81	.76	.84	.09				
Fatty[b]	100.0	91.7	91.7	1.00	.89	.90	.08				
Off	66.7^{x}	41.7^{y}	33.3^{y}	.41	.34	.24	.10				
Barny	0^{y}	8.3^{x}	8.3^{x}	—	.43	.50	.00				
Sour/off	41.7^{x}	8.3^{y}	8.3^{y}	.24	.35	.28	.08				
Livery	100.0	100.0	83.3	.74	.54	.52	.10				
Astringent	100.0	100.0	100.0	2.09	2.17	2.16	.06				
Bloody	41.7^{x}	16.7^{y}	25.0^{y}	.21	.29	.27	.06				
Metallic	66.7^{x}	25.0^{y}	50.0^{x}	.43	.27	.44	.10				
Amplitude	—	—	—	8.49	8.63	8.75	.18				

[a]Animal within dietary treatment was used as the error term.
[b]Appropriate flavor character note.
[v]Linear effect of potato by-product on intensity of this flavor note ($P < .05$).
[w]Quadratic effect of potato by-product on intensity of this flavor note ($P < .05$).
[x,y,z]Within a row and trait group, means lacking a common superscript letter differ ($P < .05$).

animals receiving 10% PB. Moreover, samples from steers fed no PB displayed a higher ($P < .05$) incidence of an inappropriate, unidentifiable "off" aftertaste than samples from steers fed 10 or 20% PB. However, samples from steers fed 10 and 20% PB had a higher ($P < .05$) incidence of an inappropriate barny aftertaste than samples from steers fed no PB. There was a linear effect ($P < .05$) of level of PB on three appropriate flavor notes. Samples from steers fed no PB had the greatest intensity of appropriate fatty aromatic and sour taste, and samples from steers fed 20% PB had the most intense appropriate salty aftertaste. These linear effects, as well as the quadratic effect of PB on the sweet taste and aftertaste, were extremely small and probably of no practical importance. Feeding 10 or 20% PB resulted in generally lower incidences of inappropriate aromatics and aftertastes, which may have a slightly beneficial affect on beef flavor, but there were some linear effects that favored feeding no PB. Moreover all of these differences were quite small and flavor amplitude was not affected by level of PB ($P > .05$).

Consumer Panel

Consumer panel scores for overall acceptability were not affected ($P > .10$) by diet and averaged 7.0 ± .07, equating to "like moderately" (data not shown). This finding confirms the findings of the trained laboratory panel that there was little or nor effect of type of dietary grain or level of PB on palatability. The differences detected by the flavor profile panel were of insufficient magnitude to affect consumer panel scores.

Overall, type of grain did not affect moisture retention properties such as thaw-drip loss and cooking loss, WBS, or trained laboratory panel scores for tenderness, juiciness, flavor intensity, and off-flavor. Roasts from steers fed corn-based diets compared to barley-based diets had slightly higher ($P < .05$) texture and flavor profile amplitude scores, but the magnitude of the differences were small (.7 and .5 units for texture and flavor amplitude, respectively) and the texture and flavor of both the barley- and corn-fed beef were well above average. Moreover, type of grain did not affect consumer panel scores for overall acceptability. Level of dietary PB did not affect moisture retention properties, shear force, trained laboratory panel tenderness, juiciness, flavor intensity and off-flavor scores, profile panel texture and flavor amplitude scores, or consumer panel overall acceptability scores.

Implications

There were no important effects of type of grain and level of potato product on drip loss, cooking loss, Warner-Bratzler shear force, or sensory panel scores; therefore, the perception that barley-based beef feedlot diets containing potato by-product results in beef with inferior water retention properties, tenderness, and palatability is unfounded. Discrimination against beef from steers fed these diets is not justified on that basis.

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