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Off-Flavor Mitigation in Cow Steaks

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Summary

Strip loins from fed (high energy diet for at least 60 days) and nonfed cows were treated with 1% water a solution containing one of four commercial bitter blockers to determine if off-flavors could be blocked. Neither trained nor consumer taste panels detected differences among the bitter blockers. Trained panelists frequently found metallic, sour, rancid, bloody, salty, and bitter flavors, with nonfed cow beef having more bloody, bitter, and burnt off-flavors. Consumers most frequently identified bloody, metallic and liver-like off-flavors in cow beef, but found no differences in frequency of off-flavor notes between fed and nonfed cow beef. Commercial bitter blockers did not improve flavor. Feeding a high energy diet for at least 60 days prior to harvest changes the flavor of cow beef.

Introduction

More than one thousand volatile compounds have been identified from cooked meats. Perception of off-flavor likely relies on both the olfactory and taste systems. Sour and bitter receptors are likely candidates for detection of off-flavors.

Most off-flavor descriptors seem unrelated to sour, so bitter receptors were the focus of this research. Past approaches to off-flavor were either to remove the troublesome compound or counteract the response (i.e., drown it out by another taste). Our approach was to study compounds that interfere with the transduction mechanism of taste in a taste-receptor cell to prevent the taste cells from ever being activated. This technology has been associated with the pharmaceutical and beverage industries to manage inherently bitter compounds. We hypothesized that incorporation of commercially available bitter blockers would improve acceptability of off-flavored beef.

Procedure

Fed (n=10) and nonfed (n=10) cows were harvested and strip loins collected at Gibbon Packing Inc. (Gibbon, Neb.), obtained from Skylark Meats (Omaha, Neb.) and delivered to the Loeffel Meat Laboratory at the University of Nebraska–Lincoln. The "fed" strips were taken from Gibbon's Prairie Premium program, which is comprised of cows 30 months of age or older that have been fed a high energy diet for at least 60 days, posses white fat, grade commercial or higher, and posses a lean score of 1-4 on a 10-point scale with 1= cherry red and 10= extremely dark. The "nonfed" strips were taken from Gibbon's commodity program, which is comprised of cows that do not fall into the branded program. Half of the strip loins were assigned to either trained or consumer panels. A replication (n=5) consisted of steaks from one strip loin, to which were applied five treatments.

Sample Preparation

The experiment was a split-plot design, with the whole plot being feed level and the split plot being treatment. For the trained panel samples, five 1-inch steaks were removed from each strip loin in succession, from anterior to posterior. For the consumer panel, 10 steaks were removed in the same manner and grouped (1 with 2, 3 with 4, etc.). Either individual or paired steaks were removed from the anterior end of each strip loin, trimmed of any external fat, and randomly assigned to one of five treatments: a control or one of four commercial bitter blockers.

A preliminary screening of 12 bitter blockers took place to identify the most promising compounds for this application. Screening involved applying the 12 bitter blockers at industry-recommended levels to a sample of ground beef with liver-like off-flavor notes (Table 1). Three evaluators conducted an informal evaluation of each product to see if the liver-like off-flavor notes were masked; products showing masking potential were selected for the study. After the screening, four products were selected and used on whole, longissimus muscle steaks at industry-recommended levels: Wixon #12006611 at 0.25%, International Fragrance and Flavor (IFF) #13559607 at 0.20%, IFF #13673888 at 0.20%, and Givaudan #513409 at 0.05% (manufacturers' information in Table 1). Five treatments were represented in each strip loin. For distribution purposes, each treatment (including control) was mixed with water so that addition of 1% of steak weight would deliver the industry-recommended level in the final product. Steaks were combined with 1% water (control) or 1% solution including the appropriate bitter blocker, vacuum packed and tumbled by replication (loin) for 15 min. After equilibrating for 24 hours, samples were frozen and stored at -20°C.

Trained Taste Panel

One-inch thick steaks were broiled on a tabletop broiler to a final internal temperature of 160°F. Temperature was monitored at the geometric center of each steak using a thermocouple thermometer. Steaks were then placed into glass double broilers; samples were held no more than 10 minutes. Immediately before serving the steaks were cut into 0.5 in x 0.5 in portions. The panel was specifically trained for evaluating tenderness, connective tissue, juiciness and to identify off-flavors, if present. The panelists received five samples per session. In a given taste panel session all samples were from the same strip loin with all treatments being represented.

Table 1. Total ingredients screened at industry recommended levels.

Ingredient	Usage	Selected	Corporate Headquarters
Wixon 12006611	0.25%	X	St. Francis, Wis.
Wixon 61004132	0.10%		St. Francis, Wis
IFF 13559607	0.20%	X	New York, N.Y.
IFF 13632175	0.20%		New York, N.Y.
IFF 13673888	0.20%	X	New York, N.Y.
Givaudan 522466	1.50%		Zurich, Switzerland
Givaudan 524293	0.20%		Zurich, Switzerland
Givaudan 513409	0.10%	X	Zurich, Switzerland
Linguagen AMP	0.40%		Cranbury, N.J.
Mastertaste VN	0.10%		Teterboro, N.J.
Mastertaste VGN	0.10%		Teterboro, N.J.

Table 2. Least square means for main effects for trained panel evaluation for tenderness, connective tissue, juiciness, and off-flavor.

Main Effect	Tenderness[a]	Connective tissue[b]	Juiciness[c]	Off-flavor[d]
Treatment				
Control	4.26	3.84	5.47	2.03
Wixon 12006611	4.24	3.77	5.43	2.07
IFF 13559607	4.59	4.10	5.56	2.16
IFF 13673888	4.65	4.20	5.37	2.33
Givaudan 513409	3.91	3.66	5.21	2.60
SEM[e]	0.35	0.36	0.24	0.19
P-value[f]	0.08	0.43	0.54	0.10
Feeding				
Fed	4.09	3.72	5.16	2.10
Nonfed	4.57	4.11	5.66	2.37
SEM[e]	0.39	0.42	0.24	0.15
P-value[f]	0.38	0.54	0.12	0.15

[a]Tenderness: 1= extremely tough; 8= extremely tender.
[b]Connective tissue: 1= abundant amount; 8= no connective tissue.
[c]Juiciness: 1= extremely dry; 8= extremely juicy.
[d]Off-flavor intensity: 0= no off-flavor; 15= very extreme amount.
[e]Standard error of the mean.
[f]*P*-value for the main effects from analysis of variance tables.

Table 3. Percentage incidence of off-flavor notes by the trained panel.

Off-flavor note	Fed[a]	Nonfed[b]	SEM[c]	*P* –value
Metallic	38.9	40.0	0.02	0.69
Sour	34.3	33.7	0.04	0.91
Rancid	20.6	22.3	0.05	0.79
Bloody	10.3[x]	22.9[y]	0.04	0.03
Bitter	9.7[x]	14.9[y]	0.02	0.02
Livery	4.0	5.1	0.02	0.73
Fatty	1.1	5.1	0.01	0.08
Burnt	0.1[x]	1.1[y]	0.01	0.04
Salty	15.4	9.1	0.03	0.16
Sweet	4.0	2.2	0.01	0.21

[a]Fed cow beef.
[b]Nonfed cow beef.
[c]Standard error of the mean.
[x,y]Means with different superscripts within the same row differ significantly ($P<0.05$).

Consumer Taste Panel

Steaks were cooked and served as described above. The panel was asked to evaluating tenderness, connective tissue, juiciness, and overall like. The panel was also asked to note any off-flavors, if present. The panelists received five samples per session. In a given taste panel session all samples were from the same strip loin with all treatments being represented.

Statistical Analysis

Data were analyzed as a split-plot design, with the whole plot being feed level and the split plot being treatment by analysis of variance (ANOVA) using the GLIMMIX procedure of SAS with a predetermined significance level of $P\leq0.05$. When significance was indicated by ANOVA, means separations were performed using the LSMEANS and PDIFF functions of SAS.

Results

Overall off-flavor intensity scores were generally low (2.03 to 2.60 on a 15 point scale); as a result there were no significant treatment effects for reducing off-flavor. Trained panelists (Table 2) showed treatments did not contribute to off-flavor ratings ($P=0.10$). Furthermore, the trained panel found no significant differences ($P>0.05$) between fed and nonfed cow beef in regards to tenderness and juiciness.

If off-flavors were present, panelists were asked to identify them. The trained panel characterized 30-40% of cow meat samples as having metallic and sour notes and 10-20% of the samples as having rancid, bloody, salty, and bitter flavor notes (Table 3). Although the trained panel found no significant differences ($P>0.05$) in off-flavor between fed and nonfed cows, they found nonfed cow meat more frequently had bloody, bitter, and burnt off-flavor notes than meat from fed cows ($P<0.05$).

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In contrast to the trained panel, the consumer panel characterized 30% of cow meat samples as having bloody notes and 10-20% of the samples as having livery and metallic flavor notes (Table 4). This may reflect a difference in how consumers interpret the meaning of off-flavor descriptors. Consumers indicated treatments did not significantly add off-flavor notes (Table 4), nor did they identify any significant differences ($P>0.05$) in frequency of off-flavor notes between fed and nonfed cows (Table 5). Consumers found nonfed cow meat to be significantly ($P=0.02$) less tender and have more connective tissue, with a tendency to have more off-flavor ($P=0.15$) and lower ratings for overall like ($P=0.10$).

In conclusion, the hypothesis that the incorporation of commercially available bitter blockers would improve acceptability of off-flavored beef was not supported. The greatest differences for both consumer and trained panel were in comparisons of fed versus nonfed cow beef rather than among the treatments within a feeding regime.

Table 4. Least square means for main effects for consumer panel evaluation for overall-like, tenderness, connective tissue, juiciness, and off-flavor.

Main Effect	Overall like[a]	Tenderness[b]	Connective Tissue[c]	Juiciness[d]	Off-flavor[e]
Treatment					
Control	5.62	4.55	5.32	4.95	2.04
Wixon 12006611	5.47	4.61	5.34	5.11	2.18
IFF 13559607	5.54	4.55	5.25	5.14	1.99
IFF 13673888	5.60	4.68	5.36	5.31	2.18
Givaudan 513409	5.35	4.36	4.94	5.12	2.24
SEM[f]	0.23	0.20	0.18	0.13	0.14
P-value[g]	0.57	0.52	0.22	0.26	0.45
Feeding					
Fed	5.89	4.96[x]	5.61[x]	5.20	1.96
Nonfed	5.15	4.15[y]	4.87[y]	5.06	2.30
SEM[f]	0.29	0.19	0.18	0.11	0.15
P-value[g]	0.10	0.02	0.02	0.36	0.15

[a]Overall like: 1= extremely dislike; 9= extremely like.
[b]Tenderness: 1= extremely tough; 8= extremely tender.
[c]Connective tissue: 1= abundant amount; 8= no connective tissue.
[d]Juiciness: 1= extremely dry; 8= extremely juicy.
[e]Off-flavor intensity: 1= slight amount; 8= extreme amount.
[f]Standard error of the mean.
[g]*P*-value for the main effects from analysis of variance tables.
[x,y]Means with different superscripts within the same column differ significantly ($P<0.05$).

Table 5. Percentage incidence of off-flavor notes by the consumer panel.

Off-flavor note	Fed[a]	Nonfed[b]	SEM[c]	*P* –value
Metallic	13.1	11.7	0.02	0.58
Sour	3.1	3.9	0.01	0.29
Rancid	5.7	4.5	0.01	0.21
Bloody	27.5	30.8	0.03	0.47
Bitter	7.2	7.9	0.01	0.61
Livery	16.6	15.9	0.01	0.72
Salty	4.5	4.5	0.01	0.98
Sweet	4.0	4.0	0.01	0.97

[a]Fed cow beef.
[b]Nonfed cow beef.
[c]Standard error of the mean.

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