Color and Sensory Properties of Beef Steaks Treated with Antimicrobial Sprays

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Summary

Beef steaks were treated with different antimicrobial sprays (560 ppm bromine, commercial blend containing 2.48% lactic acid, acetic acid, and potassium hydroxide, 4.17% lactic acid, and an unsprayed control) to determine their antimicrobial effectiveness and effect on color and palatability properties. Consumer sensory panels for Psoas major steaks revealed samples treated with lactic acid were more preferred (P = 0.05) for juiciness and flavor (P = 0.01) than all other treatments. Lactic acid and the commercial blend were the most effective antimicrobial treatments (P < 0.01) against generic E-Coli. Steaks treated with the commercial blend product showed the lowest overall discoloration (P < 0.01) resulting in the greatest consumer appeal.

Introduction

Antimicrobials are widely used on the surface of fresh beef to reduce pathogens and extend shelf life. These antimicrobials may affect properties such as color of raw meat and sensory palatability properties such as juiciness, flavor, and off-flavor of cooked meat product. The objectives of this study were to determine the effectiveness of three different antimicrobial sprays on beef steaks (bromine, commercial blend [lactic acid 45-60%, acetic acid 23-30% and potassium hydroxide >1%], lactic acid, and an unsprayed control). As well, the effects of the three different antimicrobial sprays on color and sensory properties of beef steaks were evaluated using a consumer sensory panel.

Procedure

For microbial analysis, steaks for *Psoas major* (PM; n = 180) and *Gluteus medius* (GM; n = 180) were inoculated prior to treatment with approximately 3 log of generic *E-coli* and swabs for colony forming units (CFU's) were taken to estimate microbial load. Treatments were applied via direct spray on average 560 ppm bromine, 2.48% commercial blend, and 4.17% lactic acid at 130° F. Following treatment the microbial analysis steaks were swabbed once more for CFU's. Initial CFU measurements and CFU measurement after treatment were measured within a 24 hour period.

Non-inoculated PM (n = 176) and GM (n= 176) steaks were frozen immediately after treatment and thawed prior to being used for consumer and sensory evaluation and color measurements. Subjective percent discoloration was determined by a trained panel on raw steaks in vacuum packages to emulate what consumers would see. Objective color was measured using a Minolta Chromameter CR-400 with an 8 mm diameter measurement area, illuminant D65 and a 2° standard observer. Values for L* (brightness), a* (redness), and b* (blue to yellow) were recorded.

For consumer evaluation steaks were placed on a Hamilton Beach Indoor Outdoor grill and cooked on one side till steaks reached an internal temperature of 95°F. They were then turned over and cooked on the other side until they reached an internal temperature of 160°F. Steaks were then cut into 1-cm cubes and all treatments were served in random order. Taste panels were completed over two days with 176 PM steaks prepared for day one and 176 GM steaks prepared for day two. Consumers (n = 204) evaluated steaks on a scale of one to eight for juiciness and flavor (1 = extremely undesirable, 8 = extremely desirable) and off-flavor intensity (1 = extremely mild, 8 = extremely intense). Each individual steak was evaluated by five consumers.

Each steak type was analyzed separately. Statistical analysis was conducted using SAS and a completely randomized design with the main effect being the different microbial treatments and random effect of panelist was used (in taste panel only). Analysis of Variance (ANOVA) was performed using the GLIMMIX procedure with mean separation determined using LS MEANS and DIFF LINES options of SAS, with significance determined at $P \leq 0.05$.

Results

Steaks treated with lactic acid and commercial blend were the most effective antimcrobial treatment ($P < 0.01$) (Table 1 and Table 2) for

Table 1. Mean antimicrobial treatment effects on *Psoas major* steaks.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Log before	3.00	3.07	3.13	2.99		
Log after	2.49	2.54	2.17	1.89		
Log reduction	0.51[b]	0.50[b]	0.97[a]	0.98[a]	0.0978	<.01

[a,b]Means with different superscripts within the same row differ ($P < 0.05$).

Table 2. Mean antimicrobial treatment effects on *Gluteus medius* steaks.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Log before	2.73	2.78	2.68	2.59		
Log after	2.20	2.14	1.35	1.02		
Log reduction	0.54[b]	0.64[b]	1.33[a]	1.57[a]	0.1259	<.01

[a,b]Means with different superscripts within the same row differ ($P \leq 0.05$).

Table 3. *Psoas major* color and sensory properties.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Juiciness	4.75[ab]	4.68[b]	4.69[b]	4.99[a]	0.1246	0.05
Flavor	5.39[ab]	5.40[a]	5.19[b]	5.57[a]	0.1127	0.01
Off-Flavor Intensity	2.49	2.41	2.56	2.65	0.1511	0.16
Discoloration (%)	48.14[b]	51.00[b]	37.72[c]	67.85[a]	2.670	<.01
L* (%)	42.65[a]	42.10[ab]	42.23[ab]	41.00[a]	0.3735	0.06
a* (%)	14.73[a]	14.87[a]	15.37[a]	13.72[b]	0.2128	<.02
b* (%)	9.06	9.12	9.59	9.45	0.1851	0.22

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

Table 4. *Gluteus medius* color and sensory properties.

	Control	Bromine	Blend	Lactic Acid	SEM	*P*-value
Juiciness	4.52	4.31	4.48	4.51	0.1286	0.33
Flavor	5.18	5.21	5.18	5.17	0.1073	0.99
Off-Flavor Intensity	2.75	2.65	2.74	2.83	0.1549	0.51
Discoloration (%)	43.60[b]	57.88[a]	31.82[c]	48.81[b]	2.568	<.01
L* (%)	40.11[b]	42.36[a]	40.36[a]	39.48[b]	0.3442	<.01
a* (%)	16.19[b]	15.26[c]	17.45[a]	16.08[bc]	0.2742	<.01
b* (%)	10.24[b]	10.58[b]	11.19[a]	11.09[a]	0.1477	0.02

[a,b,c]Means with different superscripts within the same row differ ($P \leq 0.05$).

both PM and GM steaks. When comparing percent discoloration (Tables 3 and 4) lactic acid treated PM steaks showed the largest percent discoloration ($P < 0.01$) compared to GM steaks where bromine treated revealed the largest percent discoloration ($P < 0.01$).

Consumer evaluation for PM steaks showed lactic acid samples were more desirable ($P = 0.05$) for juiciness and flavor ($P = 0.01$) when compared to control, bromine, and commercial blend samples. There were no significant preferences for off-flavor intensity among treatments for PM steaks. The GM steaks showed no significant preferences among treatments for juiciness, flavor, and off-flavor. In conclusion, lactic acid was the most effective for microbial treatment, but also showed the lightest color with the lowest L* value while commercial blend treated samples showed less overall discoloration and more redness (a*).

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