

FLAVOR CHARACTERISTICS OF BEEF STEAKS FROM BONELESS BOTTOM ROUNDS INJECTED WITH LOW SALT-CONTAINING SOLUTION

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BACKGROUND: Meat flavor and flavor quality are influenced by several types of factors including those of the animal, such as age, dietary regimen, length of postmortem aging and the particular primal cut (Spanier et al., 1990) and those arising from the method and extent of meat cooking. Meat cookery has a pronounced effect on palatability of a product, specifically, color, odor, texture and ultimate flavor. In addition to "natural" meat flavors, flavor quality can be modified or enhanced by use of additives such as sodium chloride (NaCl) and various phosphates.

OBJECTIVE: The objective of this study was to determine the saltiness, juiciness, first and second detectable flavors and the intensity and desirability of those flavors for beef steaks cut from rounds previously injected with solutions of low NaCl concentrations.

EXPERIMENTAL METHODS: Fresh vacuum-packaged U.S. Choice (USDA, 1989) beef IMPS #171B bottom rounds (USDA, 1993) were obtained from a local wholesaler and weighed prior to treatment. Three randomly selected rounds were each injected 20% of initial weight with one of 3 solutions to yield 0.17, 0.26, or 0.37% NaCl. Injection was accomplished using one pass through a Fomaco FGM 20/20 multi-needle injector with the solutions at 4°C. An injection yield of 19.4% was attained based on drainage for 15 min. The rounds were vacuum packaged in barrier bags (Cryovac Division, W.R. Grace & Co.), and sets of 3 rounds tumbled for 1 hr at 6 rpm at 0°C. After storage at 4°C for 4 days to allow equilibration of injected solution, the rounds were re-tumbled for 5 min, removed from the bags, trimmed of visible external fat and connective tissue and cut into 100 g steaks approximately 2.5 cm thick. Steaks were then individually vacuum packaged in barrier bags and frozen at -20°C for 2-3 months before sensory analysis. At the time of analysis, samples were thawed at 4°C, passed through a Steakmaster multi-blade tenderizer and placed on a rack in a broiler pan. With inserted thermocouples, the steaks were put into a pre-heated oven (176.7°C) and cooked at 176.7°C to an internal temperature of 70°C following the AMSA (1978) guidelines. After cooking, steaks were cut into uniform cubes with a customized template, the cubes placed into appropriately coded foam cups with lids and served to 12 trained panelists in sensory booths.

Training consisted of four 30 min sessions in which panelists defined descriptors relating to saltiness and the perceptions of flavor that might be imparted by salt as they sampled steak cubes prepared in the same manner. Group discussions were utilized. During the evaluations of experiment samples, the steaks were served to panelists immediately after cooking and were approximately 60°C. The panelists evaluated the steaks for saltiness (6 point scale: 6=not salty; 1=extremely salty), juiciness (8 point scale: 8=extremely juicy; 1=extremely dry), first detectable flavor (acidic; bitter; browned beef; cooked beef; fresh; metallic; mineral; old; phosphate; sodium), second detectable flavor (same choices), and flavor intensity (8 point scale: 8=extreme; 1=just recognizable) and flavor desirability (8 point scale: 8=extremely desirable; 1=extremely undesirable). Steaks were evaluated in duplicate at two panel sessions per replicate (Reps=3) with a total of 8 panel sessions over the entire course of the study. Steaks from an uninjected round, cooked and cubed as given above was used as a reference sample. Data for all response variables were analyzed with the General Linear Model procedure of SAS (1990). A randomized complete block design (RCB) with panelist as block was employed. Separation of means was accomplished by a Least Significant Difference test. Chi-Square was used to analyze the responses of panelists evaluating the sensory attributes.

RESULTS AND DISCUSSION: Saltiness and juiciness attributes. The mean saltiness and juiciness values of the injected beef steaks differing in NaCl concentration are given in Table 1. Perceptions of saltiness and juiciness significantly increased ($p < .05$) when NaCl concentration increased from 0.17 to 0.26%. There was no difference ($p > .05$) in saltiness or juiciness of steaks between 0.26% and 0.37% NaCl. In a separate supplementary test, panelists were asked to evaluate untreated steaks for saltiness and juiciness using the same evaluation descriptors. An average saltiness of 4.8 was found and is similar to those values observed in the treated steaks. However, the juiciness value for untreated steaks averaged 5.5 which is approximately 6 or moderately juicy, slightly higher than the value found for the treated steaks. This was likely due to the slight water binding increase by the myofibrillar protein fraction, known to occur with NaCl addition.

Approximately 53% of the panelists evaluated saltiness of steaks containing 0.17% NaCl as not salty (a value of 6.0). In steaks with 0.26% NaCl, 36% and 33% of the panelists evaluated saltiness as 5, trace of saltiness, or 6, not salty, respectively. When the steaks contained 0.36% NaCl, 45% of the panelists also evaluated the steaks as having only a trace of saltiness (or a value of 5). The juiciness attribute of the cooked steaks at 0.17% NaCl was normally distributed with the largest number of panelists describing the samples as slightly dry (value of 4). When NaCl concentration was 0.26%, the greatest number of panelists (25%) observed juiciness as 5 or slightly juicy. As NaCl concentration increased, juiciness values began to increase, indicating the steaks were perceived to be more juicy although data of Table 1 indicates there was no difference in juiciness of steaks with 0.26% and 0.36% NaCl.

First detectable flavor, intensity and desirability. Over all NaCl concentrations, the greatest percentage of panelists (78%) evaluated the steak's first detectable flavor as "cooked beef flavor." The next most frequent evaluation was for "phosphate," from approximately 10% of panelists, particularly when the salt concentration was 0.36%. Mean flavor intensity is given in Table 2. The

mean flavor intensity over all NaCl levels of the first detectable flavor was 5.3, which is moderate and the mean flavor desirability was approximately 5.0, which is slightly desirable. There was no difference in flavor intensity and flavor desirability due to NaCl concentration in the beef steaks. The distribution of panelist observations for flavor intensity was bell-shaped for all NaCl concentrations with the largest number of panelists observing flavor intensities of 5 (39%) and 6 (31%), moderate and moderate to strong, respectively. The panelist data for flavor desirability was also bell-shaped, but skewed toward moderately to extremely desirable ratings. Over all NaCl levels, the greatest number of panelists indicated that the desirability of the first detectable flavor was 6, moderately desirable.

Since the primary reason for using NaCl in processed meats is to enhance flavor and increase moisture retention, thereby affecting juiciness and tenderness, these results indicate that even at low sodium chloride levels (<0.4%) steaks were considered to have no change in saltiness at the lowest NaCl level. A degree of juiciness at NaCl concentrations of 0.26% and 0.36% was maintained, but the injected steaks were not as juicy as the untreated or reference steaks. The panelist perceptions of first detectable flavor of the untreated steaks was also "cooked beef." In addition, the intensity and desirability of the first detectable flavors followed similar trends as found for the treated steaks, in that the intensity was moderate to strong and the desirability was moderately desirable to desirable.

Second detectable flavor, intensity and desirability. Responses for second detectable flavor were not required of panelists unless a second flavor was perceived. The possibility existed for a total of 225 responses for each second detectable flavor, intensity and desirability. However, only 141 responses for each were recorded over the course of the panel. The most frequent descriptor for second detectable flavor of beef steaks with 0.17% NaCl was "mineral" (6 responses) and "old" (5 responses). Of 23 total responses for steaks with 0.17% NaCl, they were scattered over the other 8 descriptors. For steaks with 0.26% NaCl, 28 total responses were recorded, with 7 responses as "mineral," and 4 each for "metallic," "old," and "phosphate." Steaks containing 0.36% NaCl also had 9 responses with flavor descriptors of "mineral" and "phosphate." In all cases, intensities were "slight" to "slight to moderate." The most cited desirability was, as would be expected, "very undesirable" and a few "slightly undesirable."

An important point to reinforce is that the steaks did not contain phosphate and the occurrence of evaluating a "mineral" and "phosphate" flavor could be the result of inadequate training in regard to phosphate effects on flavor or, more likely, use of a description due solely to its mention in training by a few panelists.

CONCLUSION: Use of low NaCl concentrations in injection solutions was generally not detrimental to the characteristics of the cooked beef steaks. The predominant first detectable flavor for all beef steaks over the NaCl levels was "cooked beef" flavor and the overall desirability was evaluated as "moderately desirable." Panelists choices of second detectable flavor and their intensity and desirability were of low frequency and would not appear to be a focus for flavor rejection.

REFERENCES:

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Table 1. Saltiness and juiciness attributes with NaCl concentration of injected beef steaks as the main effect

Sensory Attribute	(Reference Noninjected)	NaCl concentration (%)		
		0.17	0.26	0.37
Saltiness ¹	(4.8)	5.2 ^a	4.8 ^b	4.5 ^b
Juiciness ²	(5.5)	3.9 ^a	5.0 ^b	4.7 ^b

¹For saltiness, 4 = slightly salty and 5 = trace of saltiness on a scale of 1 to 6.

²For juiciness, 4 = slightly dry and 5 = slightly juicy on a scale of 1 to 8.

^{a,b}Means in a row not having a common letter are different (p<0.05).

Table 2. Mean flavor intensity and flavor desirability attributes of the first detectable flavor with NaCl concentration of injected beef steaks as the main effect

NaCl Concentration, %	First Detectable Flavor	
	Flavor Intensity ²	Flavor Desirability ³
0.17	5.2	5.2
0.26	5.3	5.0
0.37	5.4	4.6

¹Means in the same column are not different (p>0.05).

²For flavor intensity, 5=moderate.

³For flavor desirability, 5=slightly desirable.