FLAVOR OF BEEF STEAKS FROM PHOSPHATE-INJECTED BOTTOM ROUNDS

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Keywords: beef steak, saltiness, juiciness, meat flavor, flavor intensity, phosphates

Background:

The flavor enhancement attribute of sodium chloride in meats is well known. Added phosphates, while improving functional properties may produce an "astringent metallic" note at the higher levels (0.3-0.5%) of permitted use (Trout and Schmidt, 1987). Other factors affecting meat flavor include 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 cooking.

Objective

The objective of this study was to determine if the inclusion of phosphates in a 0.37% NaCl injection concentration in beef rounds affected saltiness, juiciness, and first and second detectable flavors and flavor intensity and desirability for beef steaks cut from the rounds.

Methods

Fresh vacuum-packaged U.S. Choice beef IMPS #171B bottom rounds (USDA, 1993) were obtained from a local wholesaler on three separate dates (replicates). For each replication, three randomly selected rounds were each injected 20% of initial weight with a 1.5% NaCl solution without added phosphate (NP), or with sodium acid pyrophosphate (SAPP) or sodium tripolyphosphate (STPP) to yield 0.4% in phosphate concentration. A single pass through a Fomaco multi-needle injector produced an injection yield of 19.4% after 15 min drainage. Then rounds were vacuum-packaged in barrier bags (Cryovac-Sealed Air Corp.) and sets of 3 rounds were tumbled at 6 rpm in a Polymaid tumbler for 1 hr in a 0°C room. After equilibration for 4 days (4°C), the rounds were re-tumbled for 5 min, removed from the bags, trimmed and cut into 100 g steaks approximately 2.5 cm in thickness. Steaks were then individually vacuum-packaged in barrier bags and held at –20°C for 2-3 months before sensory analysis. Then steaks were thawed at 4°C and passed through a SteakMaster multi-blade tenderizer. Thermocouples were inserted, steaks placed on a rack in a broiler pan and placed in a pre-heated oven (176.7°C). The steaks were cooked to 70°C internally (AMSA, 1978). Cooked steaks were cut into uniform cubes with a customized template, the cubes placed in coded foam lidded cups and served to 12 trained panelists in booths illuminated with red fluorescent lighting.

In four 30 min training sessions, panelists as a group discussed and defined descriptors relating to saltiness and the perceptions of flavor that might be imparted by phosphates as they sampled steak cubes prepared in the same manner described above. For sensory evaluations, steaks were served to panelists immediately after cooking and were approximately 60°C. Panelists evaluated 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) within a total of 8 panel sessions. Steaks from a non-injected round, cooked and cubed as given above was used as a reference sample. Data for all response variables were analyzed with the GLM procedure of SAS (1996). A randomized complete block design with panelist as block was employed. Separation of means was accomplished by a LSD test (α=0.05). 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 ratings of the injected beef steaks containing 0.37% NaCl with differing added phosphate or with no phosphate are given in Table 1. Steaks with SAPP did not differ in saltiness when compared to the saltiness of steaks with NP or STPP. The saltiness attribute increased ($P<0.05$) when STPP was included as compared to that of the NP treatment. Approximately 42%, 17% and 11% of the panelist ratings for saltiness of steaks with NP were 5 (trace of saltiness), 4 (slightly salty) and 3 (salty), respectively, whereas for those containing STPP, comparable rating percentages were 31%, 18% and 20%, respectively. The saltiness rating for non-injected reference steaks containing no added salt, evaluated in a separate supplementary test, was 4.8, near the "trace of saltiness" descriptor.

Perception of juiciness of steaks with SAPP was higher ($P<0.05$) than for steaks with NP or STPP. When the pH and expressible moisture were measured, expressible moisture values related to sensory juiciness and ranked in the same order as juiciness of the steaks as follows: SAPP>NP>STPP. Tissue pH was also a factor and was lower for SAPP-containing steaks (pH 5.6) as compared to steaks with STPP (pH 6.0). Used together, this indicated that STPP slightly increased the myofibrillar protein's water binding within the steak fibrils and resulted in lower sensory juiciness ratings. Juiciness ratings for untreated steaks averaged 5.5, between moderately juicy (6) and slightly juicy (5).

First detectable flavor, intensity and desirability. Among the three injection treatments, the greatest percentage (62%) of panelist choices for first detectable flavor of the steaks was "cooked beef flavor." The next most frequently selected descriptor for first detectable flavor was "phosphate," from approximately 10% of the total choices. However, the choice of "phosphate" as a first detectable flavor is not necessarily an identification of phosphate. Hall et al. (1996) previously reported that in the absence of added phosphates, steaks containing from 0.17 to 0.37% NaCl were evaluated as having "phosphate" selected as a first detectable flavor about 10% of the time.

Mean flavor intensity and desirability of the first detectable flavor are given in Table 2. Among the steaks, there was no difference in flavor intensity or flavor desirability due to the presence or absence of phosphates. In a fairly normal distribution, injected steaks had flavor intensity of the first detectable flavor rated in the range of 5 to 6, moderate to moderately strong intensity (69% of the ratings). The highest percentage (56%) of panelist ratings for desirability was 5 to 6, slightly to moderately desirable although the rating distribution was slightly skewed to lower desirability ratings. This decreased the respective study mean (Table 2). For non-injected steaks, 68% of panelists selections were for "cooked beef" as the first detectable flavor and flavor intensity and desirability values were approximately one rating unit higher than that of the injected steaks. Based on these results for the first level of sensory quality, phosphate inclusion did not have a detrimental effect on the flavor characteristics of the steaks.

Second desirable flavor, intensity and desirability. Responses for second detectable flavor were not required of panelists unless a second flavor was perceived. Of those responses provided, the most frequent descriptors for second detectable flavor were "phosphate" (21 responses with 9 occurring when phosphate was not contained), "mineral" (24 responses with 9 in the absence of phosphates), and "old" (5 responses). In an earlier study, Hall et al. (1996) found similar responses for "phosphate" and "mineral" when steaks contained no added phosphates. The flavor intensity of these detectable attributes was frequently rated from "slight" to "slightly moderate" and, as expected for these descriptors, desirability was normally distributed around "slightly" to "very undesirable." The relatively small number of responses (of a potential of 432) for undesirable flavor and intensity of the second detectable flavor descriptors that were selected is an indication that phosphates did not have a detrimental effect on flavor characteristics of the cooked beef steaks.

Conclusion

Juiciness was improved and saltiness was not different among low salt (0.37% NaCl)-containing steaks injected to contain 0.4% SAPP. The STPP-containing steaks had a higher saltiness rating by panelists than those with no phosphate. The predominant first detectable flavor for all steaks was "cooked beef" with intensity at "moderate to moderately strong" and flavor desirability at "slightly to moderately desirable." Although "phosphate" was chosen as a flavor descriptor approximately 10% of the time, including in the absence of added phosphate, phosphate inclusion in the injection solution was not found detrimental to the flavor of the beef steaks.

References

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Technical Contribution Number 4675 of the South Carolina Agriculture and Forestry Research System, Clemson University, Clemson, South Carolina 29734-0371.

Table 1. Saltiness and juiciness attributes with type of phosphate or no phosphate in injected beef steaks as the main effect

Sensory Attribute	(Reference Non-injected)	Type of Phosphate		
		No Phosphate	Sodium Acid Pyrophosphate	Sodium Tripolyphosphate
Saltiness[1]	(4.8)	4.5[a]	4.2[ab]	4.1[b]
Juiciness[2]	(5.5)	4.7[a]	5.2[b]	4.4[a]

[1] For saltiness, 4 = slightly salty and 5 = trace of saltiness on a scale of 1 to 6.
[2] For 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 type of phosphate in injected beef steaks as the main effect

Type of Phosphate	First Detectable Flavor[1]	
	Flavor Intensity[2]	Flavor Desirability[3]
No Phosphate	5.4	4.6
Sodium Acid Pyrophosphate	5.4	4.9
Sodium Tripolyphosphate	5.2	5.1

[1] Means in the same column are not different ($P>0.05$).
[2] For flavor intensity, 5 = moderate and 6 = moderate to strong.
[3] For flavor desirability, 4 = slightly undesirable and 5 = slightly desirable.