

## Sensory Characteristics of Reduced Nitrite Bacon Manufactured by the Wisconsin Process

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### ABSTRACT

Bacon with a culture of lactic acid-forming bacteria, *Pediococcus acidilactici*, plus 0.7% sucrose and 40 or 80 mg sodium nitrite/kg (Wisconsin Process), and control bacon with 120 mg sodium nitrite/kg but no lactic acid bacteria and sucrose, were produced at three commercial bacon plants under production conditions. The bacon was stored under refrigeration for 5 to 8 wk, then subjected to sensory analyses by an experienced sensory panel. Quantitative descriptive visual analysis was performed on uncooked as well as cooked samples, and the cooked samples were served for quantitative descriptive sensory analysis. Results indicated that the test bacon with reduced amounts of sodium nitrite was as acceptable as the control bacon with no sugar and lactics, with the 80 mg/kg nitrite-bacon being the most preferred of all. These results and the results of botulinal challenge and nitrosamine tests indicate that the test process can be a satisfactory alternative to processing bacon by the conventional procedure with 120 mg sodium nitrite/kg.

Nitrite is added to bacon for antibotulinal protection as well as for flavor (6,8-11), color (6-8) and other properties (1,5,18). Because nitrite induces nitrosamine formation (2,4,12) and levels of nitrosamine formed depend on nitrite concentrations (13), it is desirable to reduce or eliminate nitrite in bacon processing. Without nitrite, however, bacon no longer has its characteristic color and flavor, hence some nitrite is necessary for practical considerations.

We have developed a bacon procedure (Wisconsin Process) which involves pumping pork bellies with a pickle containing a reduced amount of sodium nitrite plus lactic acid-forming bacteria and sucrose (16,17). As long as this bacon is properly refrigerated, the added lactic acid-forming organisms will remain largely inactive and the bacon will have normal flavor. If bacon is temperature abused, the lactic acid bacteria will grow and produce acid from sucrose, thus inhibiting growth and toxin production by *Clostridium botulinum* (16,17).

Wisconsin process bacon using a *Pediococcus acidilactici* culture was made in three commercial plants (16). This bacon had excellent antibotulinal properties and markedly reduced levels of nitrosamines (16). This paper reports on the sensory characteristics of the product.

### MATERIALS AND METHODS

#### Bacon

Bacon was produced at three commercial plants, as detailed in a previous paper (16). Briefly, each of the plants produced three lots of bacon pumped with three different pickle solutions as described in Table 1. Bacon from each of the plants was kept at a relatively high refrigeration temperature (7°C) in ca. 1-lb vacuum packages for 5 wk (Plants I and II) or 8 wk (Plant III) before analysis by the sensory panel. In addition to the test bacon described above, a commercial product from each of the plants was obtained at the same time, handled in the same manner, and used in the sensory evaluation for comparison.

#### Sensory panel

Sensory analysis was conducted in the Sensory Analysis Laboratory, Department of Food Science, University of Wisconsin, using procedures described earlier (19). Descriptive sensory analysis scales (15) were selected to characterize the influential properties of raw and cooked bacon. Panels were composed of about 28 panelists who were experienced in the sensory evaluation of foods, but they were not specifically instructed regarding the various attributes of bacon before the panel sessions. Panelists were drawn randomly from a pool of over 75 individuals who participate regularly in sensory analysis, and were composed of university staff, faculty and graduate students. Panelists evaluated three samples of bacon in each formal session.

#### Sample preparation

Cooked bacon samples were prepared in covered Westbend electric skillets at 150°C for 2 min on each side. Strips of bacon were then drained on paper toweling for ca. 15 s, and served immediately to panelists. Each panelist received one strip of each bacon sample which was placed on a quartered, white paper plate that was precoded with random three-digit numbers. For the visual evaluation of cooked and uncooked bacon, randomly selected strips of bacon from each treatment were placed on halved 9-in. white paper plates that were also coded with random, three-digit numbers.

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### Sample presentation

The panelists experienced in sensory evaluation of food products were instructed to first perform the visual evaluations of cooked bacon samples, and then participate in the taste evaluation. The visual evaluation of uncooked bacon was performed the following day, also by experienced panelists. Cooked and uncooked bacon samples were viewed under a daylight-type

lamp (ca. 168 footcandles; MacBeth Corp., Newburgh, NY). All panelists completed the visual evaluation of uncooked bacon by individually separating two strips of each sample that had been held at 5°C immediately before panelist handling. For the taste evaluation, panelists were seated in individual booths equipped with running water and indoor fluorescent lighting (ca. 78 footcandles).

TABLE 1. Treatment combinations for bacon production.

Ingredients	Treatment		
	A	B	C
NaNO <sub>2</sub> (ppm)	120	80	40
Sucrose (%)	0	0.7	0.7
<i>P. acidilactici</i>	Not added	Added	Added
Sodium ascorbate (ppm)	550 <sup>a</sup>	550 <sup>a</sup>	550 <sup>a</sup>
Sodium chloride	(A)	(A)	(A)
Sodium tripolyphosphate <sup>b</sup>	(B)	(B)	(B)

<sup>a</sup>Concentrations normally used by plant.

<sup>b</sup>Curaphos, Stauffer Chemical Co.

### Ballot

Panelists evaluated the samples using semi-structured linear scales characteristic of quantitative descriptive analysis (15). Separate scales, each with its own descriptor-labelled anchor points, were used for evaluation of selected sensory attributes. Marked judgments were coded on a seven-point basis and tabulated for statistical analysis. Definitions for all attributes were included on the ballots.

### Statistical analysis

Data from each panel session were analyzed for differences among samples using an analysis of variance appropriate for

TABLE 2. Summary of mean scores for the visual descriptive sensory analysis of uncooked bacon of Plant I.

Samples	Sample attributes						
	Color of solid lean <sup>a</sup>	Color of solid fat <sup>b</sup>	Aroma quality <sup>c</sup>	Firmness <sup>d</sup>	Ease of separation <sup>e</sup>	Stickiness (string development) <sup>f</sup>	Overall preference <sup>g</sup>
	----- Mean scores <sup>h</sup> -----						
Treatment A	2.94 <sup>A</sup>	2.81 <sup>A</sup>	4.79 <sup>A,B</sup>	4.00 <sup>A</sup>	3.39 <sup>A</sup>	4.16 <sup>A</sup>	4.14 <sup>A,B</sup>
Treatment B	4.14 <sup>B</sup>	3.79 <sup>B</sup>	5.24 <sup>B</sup>	4.94 <sup>B</sup>	3.68 <sup>A</sup>	3.56 <sup>A</sup>	4.54 <sup>A</sup>
Treatment C	4.60 <sup>C</sup>	3.87 <sup>B</sup>	4.69 <sup>A</sup>	4.10 <sup>A</sup>	3.35 <sup>A</sup>	3.59 <sup>A</sup>	3.88 <sup>B</sup>
Commercial Bacon	5.33	5.05	4.90	3.80	3.68	4.64	4.17

<sup>a</sup>Scale: 1 = pale pink; 7 = deep pinkish-red.

<sup>b</sup>Scale: 1 = grayish-white; 7 = pinkish-white.

<sup>c</sup>Scale: 1 = atypical, unexpected; 7 = typical, expected.

<sup>d</sup>Scale: 1 = not firm; 7 = firm.

<sup>e</sup>Scale: 1 = easily separated; 7 = difficult to separate.

<sup>f</sup>Scale: 1 = not sticky (no string development); 7 = very sticky (much string development).

<sup>g</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>h</sup>n = 28; mean scores in the same column with the same letters are not significantly different at the 5% level.

TABLE 3. Summary of mean scores for the visual descriptive sensory analysis of uncooked bacon of Plant II.

Samples	Sample attributes						
	Color of solid lean <sup>a</sup>	Color of solid fat <sup>b</sup>	Aroma quality <sup>c</sup>	Firmness <sup>d</sup>	Ease of separation <sup>e</sup>	Stickiness (string development) <sup>f</sup>	Overall preference <sup>g</sup>
	----- Mean scores <sup>h</sup> -----						
Treatment A	3.96 <sup>A</sup>	3.95 <sup>A</sup>	4.68 <sup>A</sup>	4.11 <sup>A</sup>	3.07 <sup>A</sup>	3.58 <sup>A</sup>	4.28 <sup>A</sup>
Treatment B	4.02 <sup>A</sup>	4.46 <sup>A</sup>	4.31 <sup>A,B</sup>	3.84 <sup>A</sup>	3.51 <sup>A</sup>	3.64 <sup>A</sup>	3.96 <sup>A</sup>
Treatment C	3.87 <sup>A</sup>	4.17 <sup>A</sup>	3.98 <sup>B</sup>	4.25 <sup>A</sup>	3.60 <sup>A</sup>	3.57 <sup>A</sup>	3.76 <sup>A</sup>
Commercial bacon	4.82	4.36	4.95	4.26	3.46	3.70	4.51

<sup>a</sup>Scale: 1 = pale pink; 7 = deep pinkish-red.

<sup>b</sup>Scale: 1 = grayish-white; 7 = pinkish-white.

<sup>c</sup>Scale: 1 = atypical, unexpected; 7 = typical, expected.

<sup>d</sup>Scale: 1 = not firm; 7 = firm.

<sup>e</sup>Scale: 1 = easily separated; 7 = difficult to separate.

<sup>f</sup>Scale: 1 = not sticky (no string development); 7 = very sticky (much string development).

<sup>g</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>h</sup>n = 28; mean scores in the same column with the same letter are not significantly different at the 5% level.

TABLE 4. Summary of mean scores for the visual descriptive sensory analysis of uncooked bacon of Plant III.

Samples	Sample attributes						Overall preference <sup>g</sup>
	Color of solid lean <sup>a</sup>	Color of solid fat <sup>b</sup>	Aroma quality <sup>c</sup>	Firmness <sup>d</sup>	Ease of separation <sup>e</sup>	Stickiness (string development) <sup>f</sup>	
	----- Mean scores <sup>h</sup> -----						
Treatment A	3.66 <sup>A</sup>	3.58 <sup>A</sup>	4.70 <sup>A</sup>	4.65 <sup>A,B</sup>	3.43 <sup>A</sup>	3.62 <sup>A</sup>	4.23 <sup>A</sup>
Treatment B	3.89 <sup>A</sup>	3.60 <sup>A</sup>	4.91 <sup>A</sup>	4.08 <sup>B</sup>	3.33 <sup>A</sup>	3.65 <sup>A</sup>	3.64 <sup>A</sup>
Treatment C	3.55 <sup>A</sup>	3.35 <sup>A</sup>	4.48 <sup>A</sup>	4.87 <sup>A</sup>	3.57 <sup>A</sup>	3.97 <sup>A</sup>	3.75 <sup>A</sup>
Commercial bacon	5.62	4.82	4.99	4.55	3.63	3.77	4.91

<sup>a</sup>Scale: 1 = pale pink; 7 = deep pinkish-red.

<sup>b</sup>Scale: 1 = grayish-white; 7 = pinkish-white.

<sup>c</sup>Scale: 1 = atypical, unexpected; 7 = typical, expected.

<sup>d</sup>Scale: 1 = not firm; 7 = firm.

<sup>e</sup>Scale: 1 = easily separated; 7 = difficult to separate.

<sup>f</sup>Scale: 1 = not sticky (no string development); 7 = very sticky (much string development).

<sup>g</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>h</sup>n = 28; mean scores in the same column with the same letter are not significantly different at the 5% level.

TABLE 5. Summary of mean scores for the visual descriptive sensory analysis of cooked bacon of Plant I.

Samples	Sample attributes					Overall preference <sup>f</sup>
	Apparent degree of doneness <sup>a</sup>	Color of solid lean <sup>b</sup>	Color of solid lean <sup>c</sup>	Color of solid fat <sup>d</sup>	Color of solid fat <sup>e</sup>	
	----- Mean scores <sup>g</sup> -----					
Treatment A	3.48 <sup>A</sup>	3.56 <sup>A</sup>	3.17 <sup>A</sup>	4.52 <sup>A</sup>	3.10 <sup>A</sup>	4.60 <sup>A</sup>
Treatment B	4.64 <sup>B</sup>	4.29 <sup>B</sup>	3.77 <sup>B</sup>	4.46 <sup>A</sup>	3.91 <sup>B</sup>	4.71 <sup>A</sup>
Treatment C	5.78 <sup>C</sup>	5.37 <sup>C</sup>	5.25 <sup>C</sup>	4.89 <sup>A</sup>	4.73 <sup>C</sup>	3.75 <sup>B</sup>
Commercial bacon	4.48	4.66	4.04	4.21	3.38	4.07

<sup>a</sup>Scale: 1 = just cooked, limp; 7 = well done, crisp.

<sup>b</sup>Scale: 1 = dark pink; 7 = dark reddish-purple.

<sup>c</sup>Scale: 1 = golden brown; 7 = dark brown.

<sup>d</sup>Scale: 1 = grey white; 7 = yellow white.

<sup>e</sup>Scale: 1 = yellowish-brown; 7 = brownish-red.

<sup>f</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>g</sup>n = 22; mean scores in the same column with the same letter are not significantly different at the 5% level.

TABLE 6. Summary of mean scores for the visual descriptive sensory analysis of cooked bacon of Plant II.

Samples	Sample attributes					Overall preference <sup>f</sup>
	Apparent degree of doneness <sup>a</sup>	Color of solid lean <sup>b</sup>	Color of solid lean <sup>c</sup>	Color of solid fat <sup>d</sup>	Color of solid fat <sup>e</sup>	
	----- Mean scores <sup>g</sup> -----					
Treatment A	4.11 <sup>A</sup>	4.66 <sup>A</sup>	3.97 <sup>A</sup>	3.30 <sup>A</sup>	3.32 <sup>A</sup>	3.52 <sup>A</sup>
Treatment B	5.33 <sup>B</sup>	4.83 <sup>A</sup>	4.63 <sup>B</sup>	4.61 <sup>B</sup>	4.36 <sup>B</sup>	4.88 <sup>B</sup>
Treatment C	5.71 <sup>C</sup>	5.76 <sup>B</sup>	5.29 <sup>C</sup>	4.20 <sup>B</sup>	4.39 <sup>B</sup>	3.33 <sup>A</sup>
Commercial bacon	4.09	3.95	3.44	4.75	3.00	4.83

<sup>a</sup>Scale: 1 = just cooked, limp; 7 = well done, crisp.

<sup>b</sup>Scale: 1 = dark pink; 7 = dark reddish-purple.

<sup>c</sup>Scale: 1 = golden brown; 7 = dark brown.

<sup>d</sup>Scale: 1 = grey white; 7 = yellow white.

<sup>e</sup>Scale: 1 = yellowish-brown; 7 = brownish-red.

<sup>f</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>g</sup>n = 21; mean scores in the same column with the same letter are not significantly different at the 5% level.

a randomized complete block design (14). For each sensory attribute, statistical analysis provided the mean scores for each sample, the F values for all samples, and the least significant difference (LSD) for making sample comparisons.

## RESULTS AND DISCUSSION

### Visual evaluation of uncooked bacon

The results of the visual evaluation of uncooked bacon are summarized in Tables 2, 3 and 4 for Plants I, II and III, respectively. The tables also include the sensory analysis results for commercial products presented as coded samples, but these results were not included in the statistical analysis. Plants I and II products were analyzed after 5 wk of storage at 7°C, whereas the storage time for Plant III products was ca. 8 wk. These storage conditions were the same for the analyses of cooked bacon. The results in Table 2 show that the "color of solid lean" of Plant I, Treatment A (120 ppm sodium nitrite, no sugar and no lactic acid organisms added) bacon was much lighter than that receiving the other two treatments. However, this was not consistent in the products of the other plants. The data for "color of solid fat" of Plant I bacon also show that Treatment A was more "greyish-white" than other treatments which were more "pinkish-white". However, again, this was not the case for the products of the other plants. Aroma of Treatment C (40 ppm sodium nitrite plus lactic acid bacteria and sucrose) of Plants I and II was slightly atypical compared with the other treatments. Treatment B bacon of Plant I was firmer than bacon receiving other treatments, but Plant III bacon produced an opposite result, indicating that this is not a characteristic property of Treatment B. There was no significant difference in slime formation (stickiness) in all products from all plants. Overall preference scores showed no significant difference between different treatments, except that for Plant I, Treatment B was most preferred and Treatment C least preferred. This, however, was not the case for the products of Plants II or III. It is apparent that there is likely to be plant-to-plant variation in sensory effects.

### Visual evaluation of cooked bacon

The results of the visual examination of cooked bacon are summarized in Tables 5, 6 and 7, for Plants I, II and III, respectively. Again, commercial products were also evaluated as coded samples, but the results were not included in the statistical analysis. The pH values of bacon at the time of the sensory evaluation are shown in Table 8, and they were generally 0.7 to 0.8 pH units lower than that of the control after several weeks of storage. This pH difference could account for visual differences of cooked bacon.

Treatment C bacon of Plants I and II appeared to be more done than other treatments, as was Treatment B of Plant III. These products had darker red/brown color of solid lean, and more brownish/yellowish solid fat. It is not known why these particular lots appeared more done than others after the standard preparation, rather than all of the lots containing sucrose. The difference in doneness must be taken into account in evaluating the results. In home cooking, the doneness is likely to be determined by visual observation and not by heating at a constant time and temperature. The overall preference scores for Plant I products may reflect the doneness of Treatment C bacon, which obtained a low score compared with bacon of other treatments, though the score still appeared within an "acceptable" range.

Treatment B bacon of Plants I and II had the highest scores overall. However, different results were observed for Plant III, with Treatment B bacon being less preferred to Treatment C. Again, Treatment B bacon was more done compared with Treatment C bacon. The results of the analysis of Plant II products showed that Treatments A and C were less preferred compared with Treatment B, but reasons for receiving unfavorable scores for these two treatments are probably different, i.e., Treatment A was less done, whereas Treatment C was more done. In any case, results of the visual observation of cooked bacon indicated that bacon with reduced amounts of sodium nitrite, lactic acid-forming bacteria and sucrose was as acceptable as bacon with 120 ppm sodium nitrite and no added sucrose.

TABLE 7. Summary of mean scores for the visual descriptive sensory analysis of cooked bacon Plant III.

Samples	Sample attributes					Overall preference <sup>f</sup>
	Apparent degree of doneness <sup>a</sup>	Color of solid lean <sup>b</sup>	Color of solid lean <sup>c</sup>	Color of solid fat <sup>d</sup>	Color of solid fat <sup>e</sup>	
	----- Mean scores <sup>g</sup> -----					
Treatment A	4.79 <sup>A</sup>	3.99 <sup>A</sup>	4.39 <sup>A,B</sup>	4.54 <sup>A</sup>	3.59 <sup>A</sup>	3.44 <sup>A</sup>
Treatment B	4.72 <sup>B</sup>	5.21 <sup>B</sup>	4.97 <sup>B</sup>	4.76 <sup>A</sup>	5.24 <sup>B</sup>	3.79 <sup>A</sup>
Treatment C	4.62 <sup>A</sup>	4.40 <sup>A</sup>	3.99 <sup>A</sup>	3.98 <sup>B</sup>	3.32 <sup>A</sup>	4.64 <sup>B</sup>
Commercial bacon	4.55	4.67	4.11	4.57	4.08	5.17

<sup>a</sup>Scale: 1 = just cooked, limp; 7 = well done, crisp.

<sup>b</sup>Scale: 1 = dark pink; 7 = dark reddish-purple.

<sup>c</sup>Scale: 1 = golden brown; 7 = dark brown.

<sup>d</sup>Scale: 1 = grey white; 7 = yellow white.

<sup>e</sup>Scale: 1 = yellowish-brown; 7 = brownish-red.

<sup>f</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>g</sup>n = 21, mean scores in the same column with the same letter are not significantly different at the 5% level.

TABLE 8. The pH values of bacon at the time of sensory analysis.

Sample		pH <sup>a</sup>
Plant	Treatment	
I	A	6.05
	B	5.22
	C	5.26
II	A	6.28
	B	5.51
	C	5.46
III	A	6.09
	B	5.42
	C	5.23

<sup>a</sup>Average of five samples.

*Sensory evaluation of cooked bacon*

The results of descriptive sensory analysis of cooked bacon are summarized in Tables 9, 10 and 11, for Plants I, II and III, respectively. The tables include the results of evaluation of commercial products but the statistical analysis does not. Aroma was not significantly different from one test product to another, and the scores from one plant were similar to the scores from another. The score for aroma of the commercial product of Plant II was higher (more typical) than the test products, probably reflecting the fact that a spice mix was used in this commercial product but not in the test products. Saltiness scores were higher for Treatments B and C bacon than for Treatment A bacon. This was likely due to the higher acidity of the former products (Table 8). The texture of Treatments B and C bacon was more crisp than that of

TABLE 9. Summary of mean scores for the descriptive sensory analysis of cooked bacon of Plant I.

Samples	Sample attributes					Overall preference <sup>f</sup>
	Aroma <sup>a</sup>	Smoke flavor intensity <sup>b</sup>	Saltiness intensity <sup>c</sup>	Off-flavor intensity <sup>d</sup>	Texture <sup>e</sup>	
	----- Mean scores <sup>g</sup> -----					
Treatment A	4.60 <sup>A</sup>	3.80 <sup>A</sup>	3.83 <sup>A</sup>	3.02 <sup>A</sup>	3.25 <sup>A</sup>	4.09 <sup>A</sup>
Treatment B	4.82 <sup>A</sup>	4.00 <sup>A</sup>	4.16 <sup>A</sup>	2.67 <sup>A,B</sup>	4.58 <sup>B</sup>	4.92 <sup>B</sup>
Treatment C	4.59 <sup>A</sup>	4.25 <sup>A</sup>	4.73 <sup>B</sup>	2.40 <sup>B</sup>	4.92 <sup>B</sup>	4.17 <sup>A</sup>
Commercial bacon	4.53	3.42	3.65	2.94	4.34	4.13

<sup>a</sup>Scale: 1 = atypical, unexpected; 7 = typical, expected.

<sup>b</sup>Scale: 1 = very weak; 7 = very strong.

<sup>c</sup>Scale: 1 = very weak; 7 = very strong.

<sup>d</sup>Scale: 1 = none; 7 = pronounced.

<sup>e</sup>Scale: 1 = not crisp, rubbery; 7 = crisp, not rubbery.

<sup>f</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>g</sup>n = 29; mean scores in the same column with the same letter are not significantly different at the 5% level.

TABLE 10. Summary of means cores for the descriptive sensory analysis of cooked bacon of Plant II.

Samples	Sample attributes					Overall preference <sup>f</sup>
	Aroma <sup>a</sup>	Smoke flavor intensity <sup>b</sup>	Saltiness intensity <sup>c</sup>	Off-flavor intensity <sup>d</sup>	Texture <sup>e</sup>	
	----- Mean scores <sup>g</sup> -----					
Treatment A	4.67 <sup>A</sup>	3.48 <sup>A</sup>	3.64 <sup>A</sup>	3.55 <sup>A</sup>	3.92 <sup>A</sup>	3.84 <sup>A</sup>
Treatment B	4.79 <sup>A</sup>	3.81 <sup>A</sup>	4.79 <sup>B</sup>	3.13 <sup>A</sup>	4.12 <sup>A,B</sup>	3.98 <sup>A</sup>
Treatment C	4.46 <sup>A</sup>	3.87 <sup>A</sup>	4.53 <sup>B</sup>	3.04 <sup>A</sup>	4.67 <sup>B</sup>	3.72 <sup>A</sup>
Commercial bacon <sup>h</sup>	5.33	4.35	4.11	2.58	4.74	4.90

<sup>a</sup>Scale: 1 = atypical, unexpected; 7 = typical, expected.

<sup>b</sup>Scale: 1 = very weak; 7 = very strong.

<sup>c</sup>Scale: 1 = very weak; 7 = very strong.

<sup>d</sup>Scale: 1 = none; 7 = pronounced.

<sup>e</sup>Scale: 1 = not crisp, rubbery; 7 = crisp, not rubbery.

<sup>f</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>g</sup>n = 28; mean scores in the same column with the same letter are not significantly different at the 5% level.

<sup>h</sup>Commercial curing solution contained added flavoring ingredients.

TABLE 11. Summary of mean scores for the descriptive sensory analysis of cooked bacon of Plant III.

Samples	Sample attributes					Overall preference <sup>f</sup>
	Aroma <sup>a</sup>	Smoke flavor intensity <sup>b</sup>	Saltiness intensity <sup>c</sup>	Off-flavor intensity <sup>d</sup>	Texture <sup>e</sup>	
	----- Mean scores <sup>g</sup> -----					
Treatment A	4.78 <sup>A</sup>	4.27 <sup>A</sup>	4.59 <sup>A</sup>	2.85 <sup>A</sup>	3.93 <sup>A</sup>	4.02 <sup>A</sup>
Treatment B	4.96 <sup>A</sup>	3.86 <sup>A</sup>	4.19 <sup>A</sup>	2.68 <sup>A</sup>	4.28 <sup>A</sup>	4.27 <sup>A,B</sup>
Treatment C	5.02 <sup>A</sup>	4.27 <sup>A</sup>	4.57 <sup>A</sup>	2.48 <sup>A</sup>	5.35 <sup>B</sup>	4.66 <sup>B</sup>
Commercial bacon	4.63	3.74	3.65	3.12	3.51	3.67

<sup>a</sup>Scale: 1 = atypical, unexpected; 7 = typical, expected.

<sup>b</sup>Scale: 1 = very weak; 7 = very strong.

<sup>c</sup>Scale: 1 = very weak; 7 = very strong.

<sup>d</sup>Scale: 1 = none; 7 = pronounced.

<sup>e</sup>Scale: 1 = not crisp, rubbery; 7 = crisp, not rubbery.

<sup>f</sup>Scale: 1 = dislike extremely; 7 = like extremely.

<sup>g</sup>n = 28; mean scores in the same column with the same letter are not significantly different at the 5% level.

Treatment A bacon. Overall preference scores showed that the test bacon was equally or more preferred than control bacon with 120 ppm sodium nitrite. The commercial bacon of Plant II received a higher overall preference score, which was likely due to the presence of spices in this product. No significant difference in smoke flavor intensity and off-flavor intensity was observed among the different treatments.

### CONCLUSION

These results indicate that bacon made by the Wisconsin Process with 40 or 80 ppm sodium nitrite, a culture of *P. acidilactici* and 0.7% sucrose was similar to bacon with 120 ppm sodium nitrite and no added lactic acid bacteria and sucrose in terms of selected visual and by-mouth sensory attributes, and was liked equally well.

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