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CONSUMER EVALUATIONS OF BACON PRODUCED WITH OR WITHOUT NITRITE AND WITH OR WITHOUT AMMONIUM HYDROXIDE/CARBON OXIDE ENHANCEMENT

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Introduction

The safe production of quality bacon without the use of sodium nitrite has been of interest for many years and was greatly debated in the United States in the 1970's (Wasserman et al., 1977). However, to obtain traditional bacon taste and color, the addition of nitrite is important. Carbon oxide addition to meat results in the formation of a stable red color that will persist during packaging and cooking at low temperatures (Jayasingh, et al., 2001). To our knowledge, carbon oxide has not been used in bacon production.

Objectives

To evaluate consumer preference of appearance and taste of bacon produced with and without sodium nitrite and with and without pH and carbon oxide enhancement (PHE) via the addition of ammonium hydroxide and dissolved carbon oxide to the brine.[1]

Methodology

Bacon Treatments. The experimental design consisted of four treatments in a 2 × 2 factorial arrangement, which included pH enhanced product (PHE) (control vs. PHE), and the addition of sodium nitrite (with nitrite vs. nitrite free). Some bellies served as controls while others were pH enhanced using a patent pending process of Freezing Machines, Inc. (FMI) at a Beef Products Inc. (BPI) production facility. Bellies were injected (ingredients expressed on percent finished product) using a pH enhanced solution also consisting of salt (1.68%); Sucrose (1.45%); sodium erythorbate (0.05%); and cure salt (0.18% - in the "with nitrite" treatments only. After the bellies were injected, they were transported to the South Dakota State University Meat Laboratory for smoking. The smoked bellies were then transported back to BPI, where they were sliced. After slicing, sample slices representing each treatment were vacuum packaged and transported to SDSU for consumer testing. One belly was used for each of the control treatments (with nitrite and nitrite free). Four bellies were used for the "PHE with nitrite" treatment and six bellies were used for the "PHE nitrite free" treatment.

[1] Patent pending, processing aid with validated pathogen reduction properties.

Panels. Consumer panels were conducted according to standards set by the American Meat Science Association. Panelists were recruited from the Brookings, SD area using fliers and newspaper advertising. One hundred eighteen consumers participated in the study over six different panel times.

Appearance Evaluation. Six representative bacon slices from each treatment were vacuum packaged in a shingle arrangement to simulate typical retail packaging. Packages were identified with random two-letter codes, placed in ice-filled trays, and evaluated by consumers under cool florescent lighting. Each panelist scored the four bacon samples (representing the four treatments) for "Overall Like of Appearance" on a 10-point scale, "Like of Color" on a 10-point scale, and "Like of the Lean to Fat Ratio" on a 10-point scale. Each panelist was also asked, "Would you be likely to purchase this bacon? (Yes or No)" based on appearance only, and each panelist was given the opportunity to write additional comments about each sample.

Taste Evaluation. Bacon was cooked in a microwave according to a predetermined length of time based on weight. These cooking times were predetermined to result in an approximate 37.5% cooking yield. Immediately following cooking, bacon strips were cut into four pieces each, placed into Styrofoam bowls with holes punched in the bottom to allow juices to drain, covered with aluminum foil, and held in a 140°F warming oven until served. Panels were conducted in booths preventing panelist interaction. Prior to the start of the panel, panelists were given brief instructions about panel procedure and were asked to sign a notice of informed consent. All samples were served under red lights to limit differences in visual appearance. One sample of each treatment was served in a random order to the panel. The first sample served was always a bacon sample obtained from the SDSU Meat Lab and was used as a warm-up sample to prevent errors associated with order of sample; this data was not included in the analysis of data nor were any conclusions drawn from that sample. Samples were coded with a random code to blind consumers to treatment combinations. Consumers rated each sample for "Overall Like", "Like of Flavor", "Crispiness", and "Tenderness" on a 10-point scale.

Results & Discussion

Figure 1 shows consumer ratings for bacon based on appearance only. Based on appearance only, consumers preferred ($P < 0.05$) PHE bacon over control bacon, regardless of whether or not if contained nitrite. In fact, consumers preferred the appearance of PHE nitrite free bacon over control bacon with nitrite. Consumers preferred ($P < 0.05$) the appearance of PHE bacon with nitrite over the PHE nitrite free bacon. Consumers liked the color of the bacon in the following order from best to worst: 1. PHE with nitrite, 2. PHE nitrite free, 3. control with nitrite, 4. control nitrite free. The control with nitrite bacon rated lower ($P < 0.05$) for "like of lean to fat ratio" than the other three treatments. Overall, PHE had twice as large of an effect at improving bacon appearance when compared to the effect of sodium nitrite.

Consumer taste ratings are shown in Figure 2. The "Overall Like" ratings almost exactly matched the "Like of Flavor" ratings, meaning that flavor is probably the primary driver in determining consumer overall satisfaction with a bacon eating experience. Of the four primary treatments, control nitrite free bacon rated the highest ($P < 0.05$) and

control with nitrite rated the lowest ($P < 0.05$), with the PHE bacons rated intermediate to the two control bacons.

The consumer rating for crispiness and tenderness are shown in Figure 3. The control nitrite free bacon rated crispier ($P < 0.05$) than the other three bacon types. Both PHE bacons were rated as more tender ($P < 0.05$) than both control bacons. Therefore, the PHE process is resulting in more tender bacon, a desirable characteristic when bacon is used as a condiment on sandwiches.

Based on appearance only, consumers said they were most likely to purchase the PHE bacon with nitrite (Figure 4). Based on appearance only, the percentage of consumers who said they would be likely to purchase the PHE bacon with nitrite was 87%, followed by PHE nitrite free bacon at 62%, control with nitrite bacon at 48%, and control nitrite free bacon at 38%. Based on taste only, the differences among the four treatments in consumers' "willingness-to-purchase" was not statistically significant.

Conclusions

In summary, consumers preferred the appearance of PHE bacon over control bacon, but they had no preference in taste for either PHE or control bacon.

References

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Tables and Figures

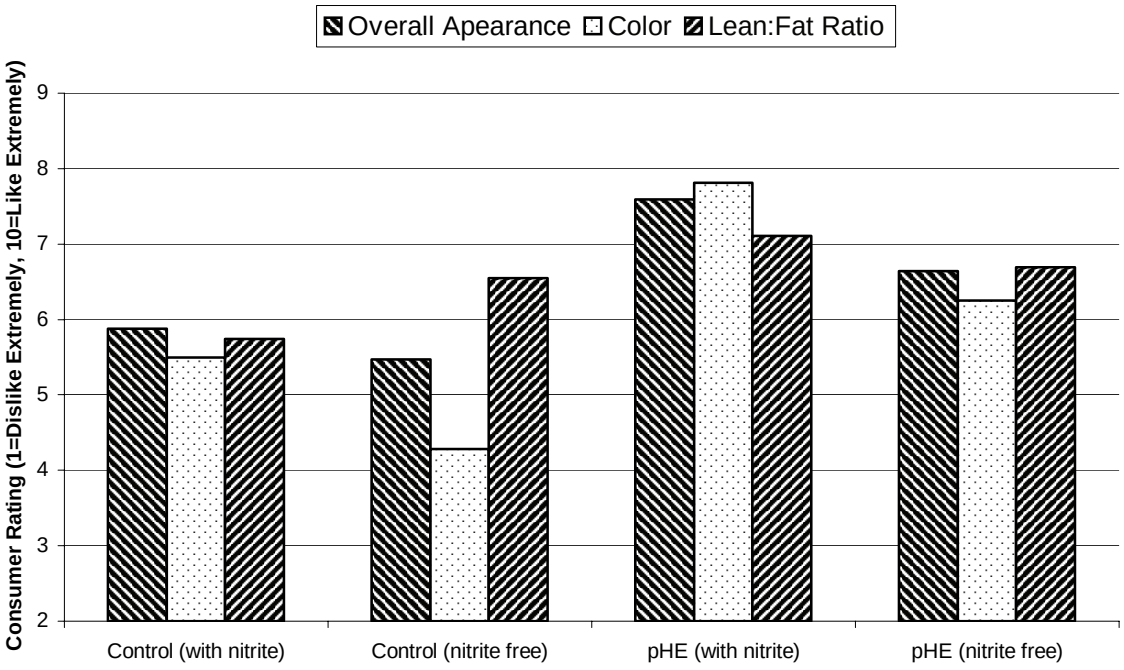

Figure 1. Consumer panel ratings of like of overall appearance, like of color, and like of lean:fat for control and pH enhanced (PHE) bacon.

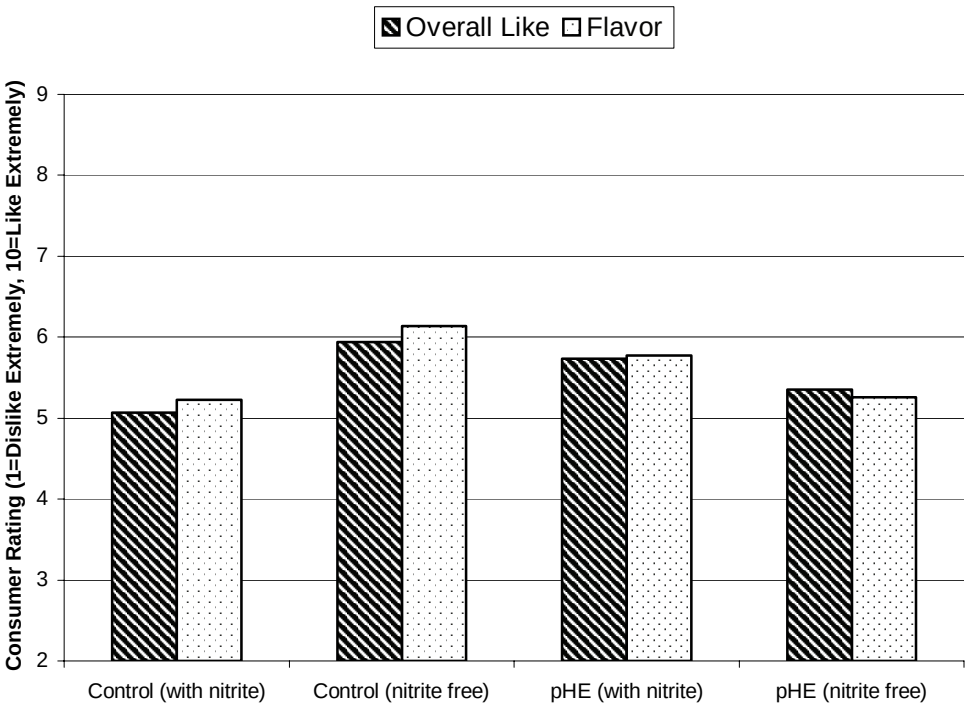

Figure 2. Consumer panel ratings for overall like and like of flavor, for control and pH enhanced (PHE) bacon.

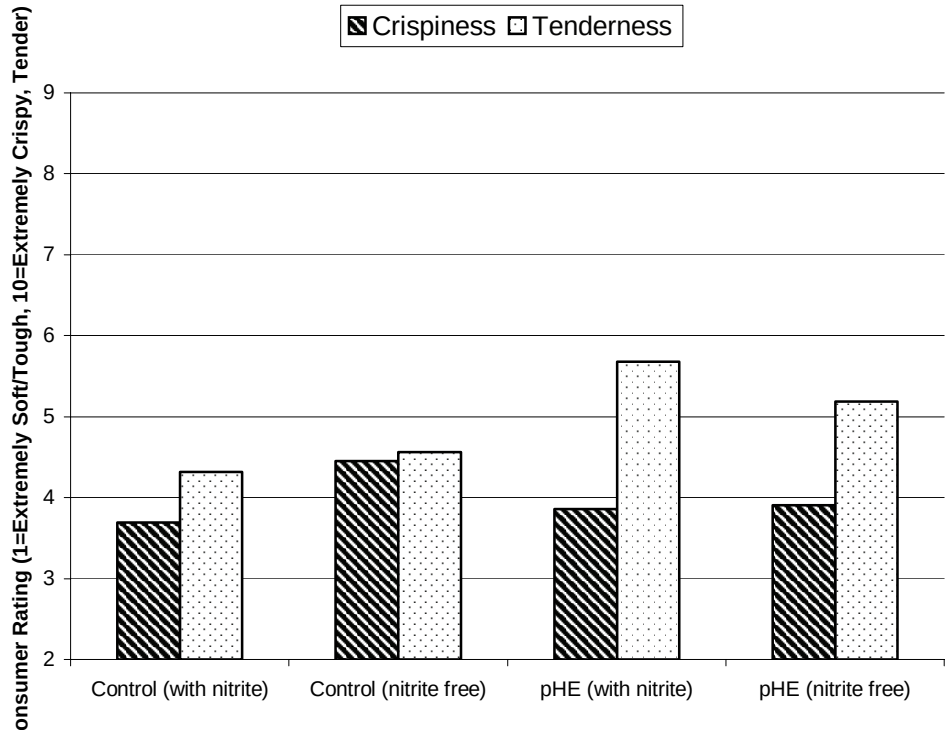

Figure 3. Consumer panel ratings for crispiness and tenderness, for control and pH enhanced (PHE) bacon.

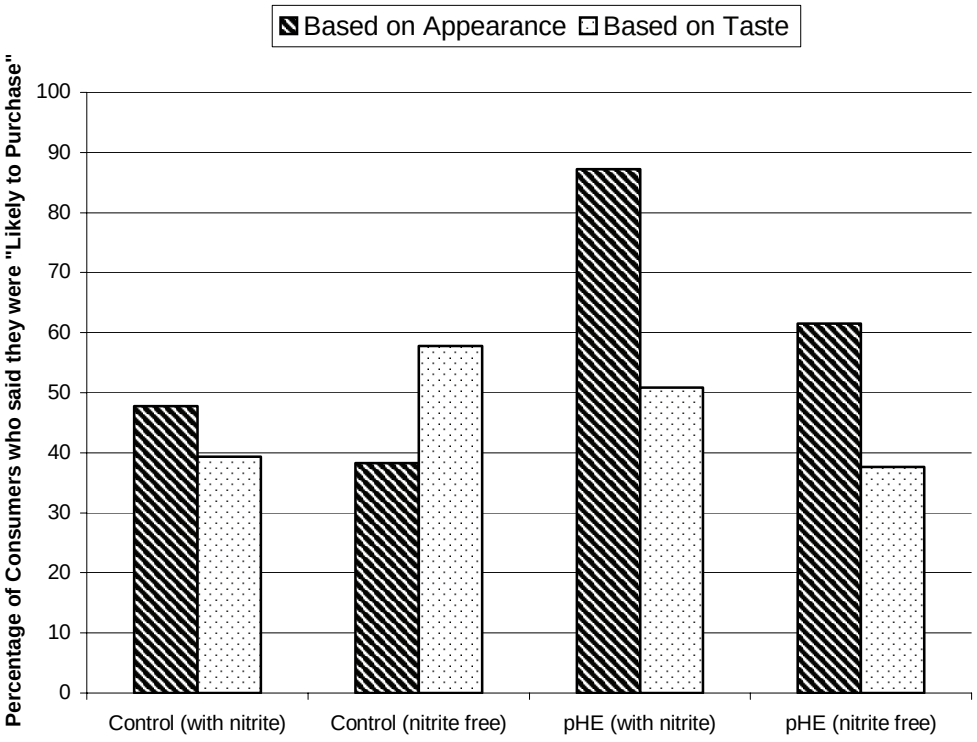

Figure 4. Consumer likelihood of purchase, for control and pH enhanced (PHE) bacon based on appearance or taste.