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ANTIMICROBIAL INGREDIENTS AFFECT BEEF SNACK STICK QUALITY

A. L. Mayer, J. A. Gunderson, A. S. Lobaton-Sulabo, E. A. E. Boyle, T. A. Houser, and J. J. Higgins[1]

Introduction

The Centers for Disease Control and Prevention estimate that 2,500 people become infected with listerosis each year by consuming food containing *Listeria monocytogenes*. Certain ready-to-eat meat and poultry products, particularly deli meats and hot dogs, are considered high risk products based on a *Listeria* risk assessment performed by the Centers for Disease Control and Prevention, the U.S. Food and Drug Administration, and the U.S. Department of Agriculture Food Safety and Inspection Service.

Meat and poultry processors use various strategies to minimize *L. monocytogenes* contamination in ready-to-eat products; one strategy is inclusion of antimicrobial ingredients. Meat snacks, including snack sticks, are popular items in the United States; $3 million of meat snacks were sold in the United States during 2007. However, these snacks typically are not produced with antimicrobial ingredients. Ional[2], Ional LC, and PURSAL Opti.Form PD4[3] are three organic acid salts that can be added to product formulations to limit *L. monocytogenes* growth. Ional contains buffered sodium citrate, and Ional LC is a combination of buffered sodium citrate and sodium diacetate that is optimized for *L. monocytogenes* control. Opti.Form contains sodium lactate and sodium diacetate. Inclusion of buffered sodium citrate is limited by the USDA Food Safety and Inspection Service to 1.3% in a formulation, but higher levels might be needed for effective *L. monocytogenes* control. Our objective was to evaluate quality characteristics and consumer preference of beef snack sticks formulated with these three antimicrobial ingredients.

Experimental Procedures

Fresh beef trimmings and beef fat obtained from the Kansas State University (KSU) Meat Lab were ground and then blended with a snack stick seasoning and cure salt (6.25% sodium nitrite). Eight treatments were formulated using 2.5% Opti.Form; 1.3, 2.5, or 3.5% Ional; 1.3, 2.5, or 3.5% Ional LC, or no antimicrobial addition (control) based on meat block weight. Meat batter was stuffed into 0.67-inch diameter collagen casings and thermally processed in a commercial smokehouse until the internal product temperature reached 155°F. After cooking, beef sticks were chilled overnight in a cooler and vacuum packaged (day 0). Smokehouse yield for each treatment was calculated (100 × Weight of thermally processed sticks/Weight of raw sticks). Treatments were replicated on three separate production days.

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[1]Department of Statistics.

[2]Ional and Ional LC are registered trademarks of World Technology Ingredients, Inc., Jefferson, GA.

[3]PURSAL Opti.Form PD4 is a registered trademark of PURAC America, Inc., Lincolnshire, IL.

Vacuum packaged beef snack sticks were stored up to 112 days in a 34°F walk-in cooler. Moisture, fat, and protein content were analyzed from samples collected on day 0 for each treatment. Water activity and pH levels for each of the eight treatments were determined on days 0, 28, 56, 84, and 112 of storage. Sensory analysis was conducted at the KSU Meat Sensory Lab on day 28 using a trained panel. Twelve panelists rated each treatment for sensory attributes on an eight-point scale: 1 = not at all salty/biter/sour/ spicy, abundant off flavor, extremely soft/undesirable; 8 = extremely salty/bitter/ sour/spicy, no off flavor, extremely firm/desirable. Warner-Bratzler Shear Force (WBSF) was measured on day 28. On day 30 of storage, 180 consumer panelists ranked snack stick samples for saltiness (1 = lacking saltiness extremely; 7 = extremely too salty) and overall acceptability (1 = dislike extremely; 7 = like extremely).

Results and Discussion

Smokehouse yield and WBSF averaged 76.34% and 13.16 lbs., respectively, and were not affected by addition of antimicrobial ingredients (Table 1). Fat, moisture, and protein, were also unaffected by antimicrobial ingredient additional and averaged 23.82%, 44.45%, and 22.94%, respectively.

Use of any of these antimicrobials reduced beef snack stick water activity to 0.923 or less compared with 0.928 for the control. Some strains of *L. monocytogenes* are capable of growing at a water activity of 0.90 under ideal conditions, but most are inhibited from growing at a water activity of 0.92. Reducing water activity in beef snack sticks closer to the minimum for growth in combination with other hurdles makes it more challenging for the organism to grow. Compared with the control, pH level of beef snack sticks declined with addition of all levels of Ional or Ional LC but not with 2.5% Opti.Form. For both water activity and pH, significant differences ($P<0.05$) were found for days of storage, but no treatment by day interaction was observed. During storage, overall pH declined from 5.72 on day 0 to 5.48 on day 84. Water activity decreased from 0.917 on day 0 to 0.912 on day 84.

Trained sensory panelists found beef snack sticks containing a higher percentage of antimicrobial ingredients to be softer and lower in overall acceptability than those containing a lower percentage or no antimicrobial at all. As antimicrobial level increased, perception of snack stick sourness and saltiness also increased. Panelists tended to score snack sticks with a higher percentage of antimicrobial ingredients higher in spice intensity. Bitterness and off-flavor scores of snack sticks containing antimicrobials were similar to the control.

Consumer panelists found the control beef snack sticks to be less salty than those with added ingredients, and perceptions of saltiness increased as antimicrobial level increased. Beef snack sticks containing 2.5 and 3.5% Ional were perceived to be the most salty. Snack sticks containing 3.5% Ional and Ional LC were ranked lowest in overall consumer acceptability, while sticks formulated with 1.3% Ional were the most acceptable. Consumers' perceptions of saltiness and overall acceptability had an inverse relationship.

Implications

Incorporating currently approved levels (1.3% Ional and Ional LC) of some antimicrobial ingredients into beef snack sticks can enhance consumer acceptability of beef snack sticks without reducing yield and impart a slightly tangier flavor to the product**.**

Table 1. Quality Traits of Beef Snack Sticks Formulated with Three Antimicrobial Ingredients

	Treatments							
Trait	Control	Ional 1.3%	Ional 2.5%	Ional 3.5%	Ional LC 1.3%	Ional LC 2.5%	Ional LC 3.5%	Opti.Form 2.5%
Fat, %	24.58	23.79	24.24	23.73	23.12	23.22	23.40	24.49
Moisture, %	44.38	45.37	43.19	42.48	44.98	44.29	43.46	47.44
Protein, %	23.49	22.61	22.91	22.78	23.49	22.92	22.54	22.82
pH	5.75^{e}	5.59^{cd}	5.49^{ab}	5.41^{a}	5.63^{d}	5.56^{bcd}	5.53^{bc}	5.76^{e}
Water activity, a_w	0.928^{e}	0.923^{d}	0.911^{b}	0.903^{a}	0.920^{d}	0.909^{b}	0.902^{a}	0.917^{c}
Smokehouse yield, %	76.93	75.81	76.26	76.63	75.55	76.21	76.57	76.75
Warner-Bratzler shear force, lb	13.38	13.45	13.62	13.23	12.72	12.83	12.32	13.76
Sensory traits[1]								
Texture	6.16^{e}	5.08^{c}	4.43^{b}	3.36^{a}	5.41^{cd}	4.51^{b}	3.73^{a}	5.88^{de}
Saltiness	4.68^{a}	5.04^{ab}	5.76^{d}	5.80^{d}	5.08^{ac}	5.41^{bcd}	5.78^{d}	4.82^{a}
Bitterness	1.13	1.10	1.15	1.24	1.20	1.18	1.26	1.18
Sourness	2.31^{a}	2.80^{b}	3.57^{c}	4.04^{d}	2.53^{a}	3.34^{c}	4.15^{d}	2.47^{a}
Spice	4.97^{a}	5.16^{ab}	5.54^{c}	5.45^{bc}	4.90^{a}	5.25^{abc}	5.37^{bc}	5.00^{a}
Off flavor	7.81	7.84	7.87	7.88	7.82	7.84	7.84	7.67
Overall	5.80^{c}	5.46^{b}	5.21^{b}	4.55^{a}	5.78^{c}	5.29^{b}	4.77^{a}	5.82^{c}
Consumer traits[2]								
Overall acceptability	4.84^{c}	5.11^{d}	4.81^{c}	4.22^{a}	5.06^{cd}	4.96^{cd}	4.48^{b}	4.97^{cd}
Saltiness	3.67^{a}	3.98^{b}	4.65^{de}	4.78^{e}	3.87^{b}	4.37^{c}	4.56^{cd}	3.96^{b}

^{abcde}Means within a row without a common superscript letter differ ($P<0.05$).

[1]1 = not at all salty/bitter/sour/spicy, abundant off flavor, extremely soft/undesirable; 8 = extremely salty/bitter/sour/spicy, no off flavor, extremely firm/desirable.

[2]Overall acceptability (1=dislike extremely; 7=like extremely); Saltiness (1=lacking saltiness extremely; 7=extremely too salty).