High Pressure Processing Effects on All Beef Summer Sausage Quality

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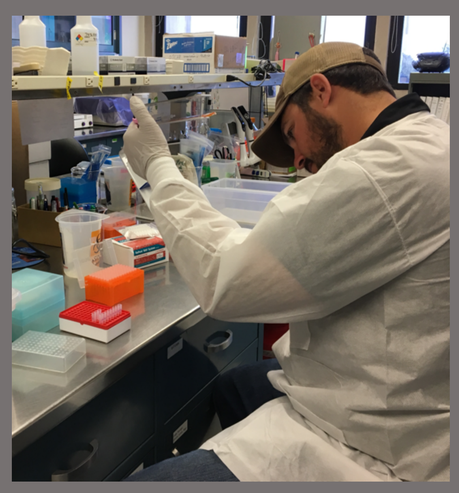
Introduction

- Current summer sausage production parameters are dictated by the necessity to meet USDA FSIS performance standards for *E. coli* O157:H7
- Alternatives to cooking such as high pressure processing (HPP) may allow for processing with greater pH and lower temperatures while still meeting performance standards
- The effect of HPP and different processing parameters on sausage quality is not known
- The objective of this project was to evaluate HPP in combination with greater pH and minimal heat treatment for their effects on sausage quality



Material & Methods

- All-beef summer sausage products (11% fat) were produced following:
  A. pH 4.6, 54.4°C with a traditional smoke house and cooler chill (T)
  B. pH 5.0, 54.4°C T
  C. pH 5.0, 54.4°C with ice bath chilling (RC)
  D. pH 5.0, 48.9°C RC
  E. pH 5.0, 43.3°C RC
- Sausages were sliced, vacuum packaged, and subjected to HPP at 586 MPa for 0, 1, 150, or 300 seconds
- Sausages were evaluated for: proximate analysis, lipid oxidation, objective color, texture profile analysis (hardness, springiness, cohesiveness, gumminess, and chewiness), and sensory characteristics (firmness, cohesion, springiness, and gumminess)
- Data were analyzed using Proc Mixed (SAS v9.4), as a completely randomized split plot design

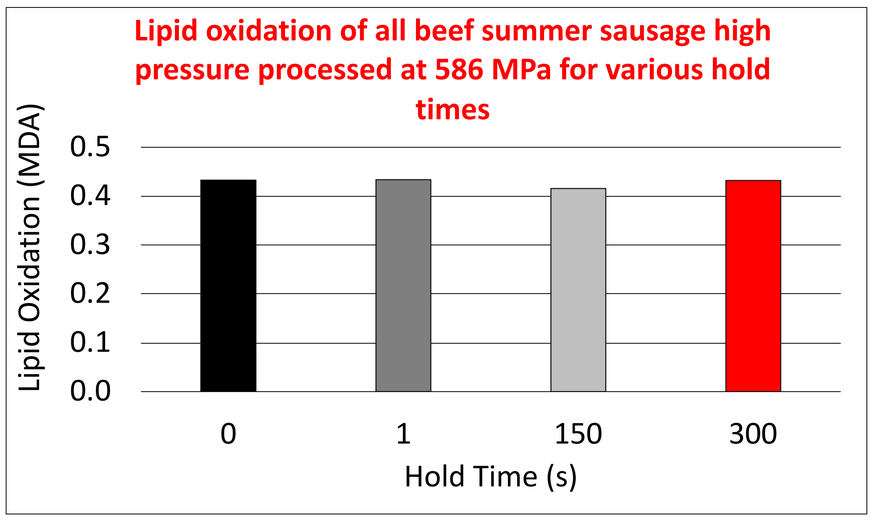
Results

Proximate analysis parameters of all beef summer sausage fermented and cooked to varying degrees of doneness

			Water Activity by Cook Temperature				Moisture:Protein by Cook Temperature			
	pH	Fat Content (%)	54.4°C T[1]	54.4°C	48.9°C	43.3°C	54.4°C T[1]	54.4°C	48.9°C	43.3°C
High Acid	4.60 ± 0.02[b]	8%	0.96 ± 0.001[c]				3.0 ± 0.07			
Low Acid	5.03 ± 0.02[a]	11%	0.96 ± 0.001[bc]	0.97 ± 0.001[b]	0.97 ± 0.001[b]	0.97 ± 0.001[a]	3.0 ± 0.07	3.0 ± 0.07	3.1 ± 0.07	3.1 ± 0.07

[abc] Means within a heading with different superscript differ; $P < 0.05$
[1] Temperatures designated by a T indicate a traditional smokehouse and cooler chilling method all remaining samples were chilled using rapid ice water chilling

Lipid oxidation of all beef summer sausage high pressure processed at 586 MPa for various hold times



Trained sensory analysis of all beef summer sausage high pressure processed at 586 MPa for varying hold times

High Pressure Hold Time (sec)	Firmness[1]	Springiness[1]	Cohesiveness[1]	Gumminess[1]
0	7.6	7.6	8.0	7.7
1	7.6	7.5	8.1	7.7
150	7.7	7.7	8.1	7.9
300	7.8	7.6	8.2	8.0
Standard Error	0.1	0.1	0.1	0.1

[abc] Means within a column with different superscript differ; $P < 0.05$
[1] Firmness, Springiness, Cohesiveness, and Gumminess were measured on a 15 cm line scale with anchors at 0, 7.5, and 15 cm indicating least intensity, average intensity and greatest intensity, respectively

Instrumental texture analysis of all beef summer sausage high pressure processed at 586 MPa for various hold times

High Pressure Hold Time (sec)	Hardness (N)	Springiness (%)	Cohesiveness	Gumminess	Chewiness
0	55.7	62.9[ab]	0.296	16.4[ab]	1040[a]
1	52.5	61.8[b]	0.293	15.3[c]	949[b]
150	54.9	63.4[a]	0.295	16.1[bc]	1025[a]
300	56.8	64.0[a]	0.302	17.1[a]	1098[a]
Standard Error	1.5	0.5	0.013	0.4	27

[abc] Means within a column with different superscript differ; $P < 0.05$

Objective color scores of all beef summer sausage high pressure processed at 586 MPa for varying hold times

High Pressure Hold Time (s)	L*	a*	b*	Fade
0	52.13	24.56[a]	14.84[a]	0.27[b]
1	52.27	24.38[ab]	14.71[b]	0.27[ab]
150	52.48	24.24[bc]	14.67[b]	0.27[ab]
300	52.69	24.05[c]	14.60[b]	0.28[a]
Standard Error	0.22	0.07	0.04	0.002

[abc] Means within a column with different superscript differ; $P < 0.05$

Objective color scores of all beef summer sausage cooked to varying degrees of doneness

Cooking Treatments[1]	L*	a*	b*	Fade
Treatment A	53.21[a]	23.83[c]	14.58[b]	0.28[a]
Treatment B	52.24[b]	24.28[b]	14.57[b]	0.27[b]
Treatment C	52.43[b]	24.27[b]	14.56[b]	0.27[b]
Treatment D	51.96[b]	24.62[a]	14.89[a]	0.27[b]
Treatment E	52.12[b]	24.54[a]	14.92[a]	0.27[b]
Standard Error	0.24	0.08	0.04	0.002

[abc] Means within a column with different superscript differ; $P < 0.05$
[1] Cooking treatment endpoint parameters are as follows: A – pH 4.6 54.4°C with traditional smokehouse chilling, B – pH 5.0 54.4°C with traditional smokehouse chilling, C – pH 5.0 54.4°C with rapid ice bath chilling, D - pH 5.0 48.9°C with rapid ice bath chilling, E - pH 5.0 43.3°C with rapid ice bath chilling

Trained sensory analysis of all beef summer sausage cooked and fermented to varying degrees of doneness

Cooking Treatments[1]	Firmness[2]	Springiness[2]	Cohesiveness[2]	Gumminess[2]
Treatment A	8.4[a]	8.0[a]	8.6[a]	8.5[a]
Treatment B	7.8[b]	7.7[ab]	8.1[b]	7.9[b]
Treatment C	7.7[bc]	7.6[bc]	8.1[b]	7.9[bc]
Treatment D	7.4[cd]	7.5[bc]	7.9[bc]	7.5[cd]
Treatment E	7.1[d]	7.2[c]	7.8[c]	7.3[d]
Standard Error	0.1	0.1	0.1	0.1

[abc] Means within a column with different superscript differ; $P < 0.05$
[1] Cooking treatment endpoint parameters are as follows: A – pH 4.6 54.4°C with traditional smokehouse chilling, B – pH 5.0 54.4°C with traditional smokehouse chilling, C – pH 5.0 54.4°C with rapid ice bath chilling, D - pH 5.0 48.9°C with rapid ice bath chilling, E - pH 5.0 43.3°C with rapid ice bath chilling
[2] Firmness, Springiness, Cohesiveness, and Gumminess were measured on a 15 cm line scale with anchors at 0, 7.5, and 15 cm indicating least intensity, average intensity and greatest intensity, respectively

Instrumental texture analysis of all beef summer sausage cooked and fermented to varying degrees of doneness

Cooking Treatment	Hardness (N)	Springiness (%)	Cohesiveness	Gumminess	Chewiness
Treatment A	66.3[a]	63.5[ab]	0.324[a]	21.1[a]	1340[a]
Treatment B	55.4[b]	65.0[a]	0.292[b]	16.1[b]	1053[b]
Treatment C	54.0[bc]	63.8[ab]	0.286[b]	15.4[bc]	986[bc]
Treatment D	50.9[cd]	62.7[b]	0.286[b]	14.4[cd]	907[cd]
Treatment E	48.2[d]	60.2[c]	0.296[b]	14.1[d]	854[d]
Standard Error	1.6	0.6	0.006	0.4	30

[abc] Means within a column with different superscript differ; $P < 0.05$
[1] Cooking treatment endpoint parameters are as follows: A – pH 4.6 54.4°C with traditional smokehouse chilling, B – pH 5.0 54.4°C with traditional smokehouse chilling, C – pH 5.0 54.4°C with rapid ice bath chilling, D - pH 5.0 48.9°C with rapid ice bath chilling, E - pH 5.0 43.3°C with rapid ice bath chilling

Conclusion

High pressure processing at 586 MPa for up to 300 seconds can be used as an alternate method for manufacturing beef summer sausages with marginal impacts on final product quality. Further research needs to be conducted to evaluate the efficacy of the process in reducing E. coli O157:H7 and other STEC populations using this alternate summer sausage manufacturing process.

Acknowledgments

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