HIGH PRESSURE PROCESSING EFFECTS ON ALL BEEF SUMMER SAUAGE QUALITY

Macc Rigdon[1*], Harshavardhan Thippareddi[1], Chevise L. Thomas[1], Robert McKee[1], Alexander M. Stelzleni[1]

[1]The University of Georgia, Athens, GA 30602, USA

*Corresponding author email: mrigdon@uga.edu

I. INTRODUCTION

In the United States market, consumers are seeking specialty food products and traditionally processed foods [1,2]. Subsequent to an *E. coli* O157:H7 outbreak associated with commercially produced dry-cured salami [3], the industry formed a Blue-ribbon Task Force to outline processes that achieve sufficient reduction of *E. coli* O157:H7 during manufacture of such traditionally produced products [4]. The majority of the processes outlined, include a mild thermal processing step [5], which could result in significant negative impacts on the sensory characteristics of the products.
High pressure processing has the ability to aid in the reduction of pathogenic bacteria [6,7] and is therefore a viable option for the hurdle technology approach presented by the Blue Ribbon Task Force. High pressure processing (HPP) is a technique where the food substrate is subjected to extreme pressures (500 - 700 MPa) through forced water displacement [7]. Cheftel *et al.* [7] explains that because the pressure is created from forced water, the distribution of that pressure is isostatic and pseudo-instantaneous, therefore does not cause product deformation, provided there is no significant amount of gas present in the food system. Although there should be no product deformation, the pressures reached during HPP are enough to influence higher energy state molecules, such as those with weak hydrostatic interactions, which could negatively influence texture and quality characteristics. The objective of the current study was to determine if HPP at levels shown to inactive pathogens influence beef summer sausage quality when fermented and thermally processed to different endpoints.

II. MATERIALS AND METHODS

Three replicates of all-beef summer sausage products (11% fat) were produced following: (i) pH 4.6, 54.4°C with a traditional smoke house and cooler chill (T); (ii) pH 5.0, 54.4°C T; (iii) pH 5.0, 54.4°C with ice bath chilling (RC); (iv) pH 5.0, 48.9°C RC; and (v) pH 5.0, 43.3°C RC. After chilling, sausages were sliced (3.1 mm), vacuum packaged, transported to a commercial HPP processor, and subjected to HPP at 586 MPa for 0, 1, 150, or 300s. Post HPP sausages were evaluated for proximate analysis (n=9), lipid oxidation (n=9), objective color (n=9), texture profile analysis (n=15; hardness, springiness, cohesiveness, gumminess, and chewiness), and sensory characteristics (n=9) including firmness, cohesion, springiness, and gumminess. Data were analyzed using Proc Mixed (SAS Inst v9.4), as a completely randomized split plot design. The raw sausage chubs were considered the whole plot to which cooking treatments were applied, and the cooked chubs were the split plot, to which HPP times were applied. Means were separated at $\alpha \leq 0.05$.

III. RESULTS AND DISCUSSION

The fat content of the sausages were similar ($P = 0.17$) among all treatments. There was no difference for moisture to protein ratio attributed to final pH and cooking endpoint or HPP time ($P > 0.63$). There was also no main effect due to pH and cooking endpoint ($P = 0.45$) or HPP ($P = 0.69$) for lipid oxidation. Objective color measurements of summer sausage products fermented to pH 4.6, heated to 54.4ºC, and traditionally chilled were lighter in color (greater L*; $P < 0.01$) than all other pH and cooking endpoint combinations, which were similar ($P > 0.17$). Additionally, treatment (i) was less red (lower a*; $P < 0.01$) than all other treatments, while (iv) and (v) exhibited the greatest redness ($P < 0.01$). Samples became less red and had more color fade as HPP time increased ($P < 0.05$), however, the differences were small in magnitude (0.51 for a* and 0.01 for fade, respectively). Vacuum packaged cooked mutton patties pressurized to 400 MPa for

10 min were found to have similar L*, a*, and b* values to the non-pressurized control [9]. In cold smoked whole muscle salmon, the application of HPP lightened the objective color of samples as HPP increased in pressure from 0 MPa to 600 MPA for 120s, however a* and b* values did not differ between treatments [10]. These two studies are contrary to each other concerning product lightness but both agree that HPP did not affect product redness (a*) or yellowness (b*).

Texture profile and sensory characteristic analysis were in agreement and showed that as cooking intensity increased so did the hardness of the sausage ($P < 0.01$). Similar trends were noted between sensory characteristics and texture profile analysis where a positive correlation between cooking intensity and the springiness, cohesiveness, and gumminess of the sausage products was observed. High pressure processing also had an effect on springiness and gumminess ($P < 0.05$), however sensory panelists were unable to detect differences ($P > 0.46$) for these same attributes. Additionally, sensory panelists were not able to distinguish a difference ($P > 0.63$) between HPP times for hardness, and cohesiveness. Claus *et al.* [8] similarly reported a high correlation between instrumental texture described as hardness and sensory texture described as firmness, as well as correlations between objective and subjective springiness, and cohesiveness.

IV. CONCLUSION

High pressure processing at 586 MPa for up to 300s 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 population using this alternate summer sausage manufacturing process.

ACKNOWLEDGEMENTS

This work was supported by USDA AFRI grant no. 2012-68003-30155 and Foundational CARE Program, grant no. 2015-09167/project accession no. 1009369 from the USDA National Institute of Food and Agriculture.

REFERENCES

1. Ilbery, B., and Kneafsey M. (1999). Niche Markets and Regional Speciality Food Products in Europe: Towards a Research Agenda. Environment and Planning A. 31(12): 2207-2222.
2. Guerrero, L., Guàrdia M. D., Xicola J., Verbeke W., Vanhonacker F., Zakowska-Biemans S., Sajdakowska M., Sulmont-Rossé C., Issanchou S., Contel M., Scalvedi M. L., Granli B. S., and Hersleth M. (2009). Consumer-driven definition of traditional food products and innovation in traditional foods. A qualitative cross-cultural study. Appetite 52(2): 345-354.
3. CDC. (1995). *Escherichia coli* O157:H7 Outbreak Linked to Commercially Distributed Dry-Cured Salami -- Washington and California, 19994. https://www.cdc.gov/mmwr/preview/mmwrhtml/00036467.htm (Accessed September 2017).
4. Reed, C. (1995). Challenge study–*Escherichia coli* O157: H7 in fermented sausage. Letter to plant managers. Washington, DC: US Department of Agriculture. Food Safety and Inspection Service
5. Nickelson II, R. (1996). Dry Fermented Sausage and E. coli O157:H7. 11-316.
6. Patterson, M. F., Quinn M., Simpson R., and Gilmour A. (1995). Sensitivity of vegetative pathogens to high hydrostatic pressure treatment in phosphate-buffered saline and foods. Journal of Food Protection 58(5): 524-529.
7. Cheftel, J. C., and Culioli J. (1997). Effects of high pressure on meat: A review. Meat Science 46(3): 211-236.
8. Claus, J. (1995). Methods for the objective measurement of meat product texture. Paper presented at the Reciprocal Meat Conference Proceedings (pp. 96-101).
9. Banerjee, R., Jayathilakan, K., Chauhan, O., Naveena, B., Devatkal, S., & Kulkarni, V. (2017). Vacuum packaged mutton patties: Comparative effects of high pressure processing and irradiation. Journal of Food Processing and Preservation *41*(1).
10. Lebow, N. K., DesRocher, L. D., Younce, F. L., Zhu, M. J., Ross, C. F., & Smith, D. M. (2017). Influence of high-pressure processing at low temperature and Nisin on *Listeria* innocua survival and sensory preference of dry-cured cold-smoked salmon. Journal of Food Science 82(12): 2977-2986.