THE EFFECT OF XANTHAN GUM ON THE EFFICACY OF LAMINATED ANTIMICROBIAL FILMS TO INHIBIT FOODBORNE PATHOGENS ASSOCIATED WITH BEEF PRODUCTS

Brittani Bedford, Veronica Stefanick, Rachel Godshall, and Catherine Cutter*

Department of Food Science, Pennsylvania State University, University Park, PA 16802; United States

*Corresponding author email: cnc3@psu.edu

I. INTRODUCTION

Active packaging is an emerging technology that is used to extend the shelf-life and ensure the safety of food products. Antimicrobial packaging, a segment of active packing, incorporates antimicrobial agents into or onto the packaging materials. Laminated antimicrobial films (LAFs) have been developed by coating a mixture of pullulan, xanthan gum (XG), and lauric arginate (LAE), a broad-spectrum, cationic surfactant, onto the polyethylene side of ethylene vinyl alcohol (EVOH) films (Figure 1**)** [1]. The resulting LAFs can improve meat and poultry products' microbial quality and safety. When combined with anionic polysaccharides such as XG, LAE can form soluble or insoluble complexes through electrostatic interactions [2]. The complexes formed may reduce the availability of LAE in the aqueous segment of food, thereby affecting its antimicrobial activity. This study evaluated the impact of XG in the formulation of LAFs on the antimicrobial activity of LAE through a series of *in vitro* and *in situ* experiments.

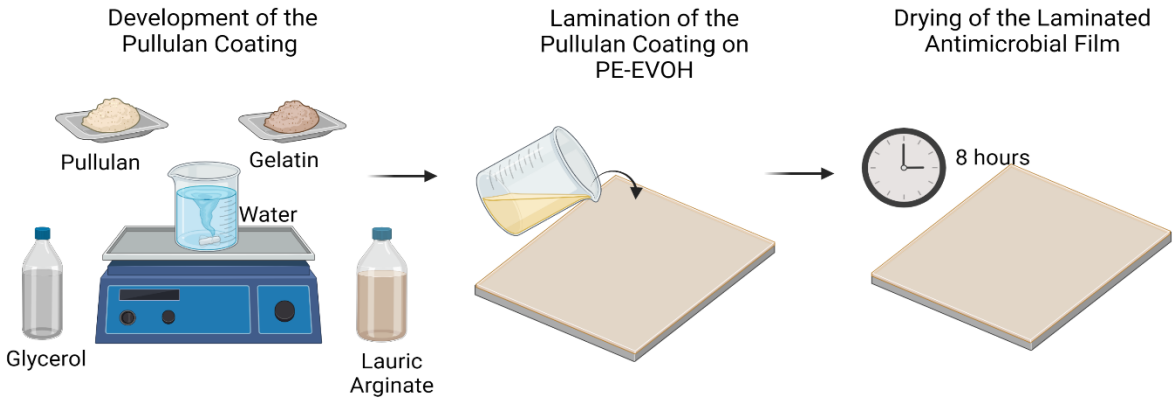

Figure 1: The development of laminated antimicrobial film (LAF) created with Biorender.com.

II. MATERIALS AND METHODS

Plate overlay analyses of approximately 7 $\log_{10}$ CFU/ml of a panel of pathogenic and non-pathogenic *Listeria* spp. and *E. coli* spp. (*L. innocua, L. seeligeri, L. monocytogenes* J1003, J129, *E. coli* O157:H7, O111, O157:H12, and O150:H8), were performed to demonstrate the antimicrobial activity of LAFs containing 0 and 0.2% XG (n=54). EVOH was used as a negative control. A subsequent challenge study was conducted using non-pathogenic *E. coli* and *Listeria* spp. that were experimentally inoculated onto 25 cm^2 of raw beef and ready-to-eat (RTE) roast beef to obtain populations of ~8 $\log_{10}$CFU/cm^2. The inoculated meats were packaged in EVOH and LAFs containing 0 and 0.2% XG for the remaining microbial populations to be determined up to 28 days at 6˚C (n=63). Modified Oxford and Sorbitol MacConkey agar was used for the enumeration of *Listeria* spp. and *E. coli*. The experimental data were analyzed using a one-way ANOVA followed by a Tukey comparison in Minitab 2022. All treatments were performed in triplicate.

III. RESULTS AND DISCUSSION

In the *in vitro* evaluations using a plate overlay of approximately 7 $\log_{10}$ CFU/ml of a panel of pathogenic and non-pathogenic *Listeria* spp. and *E. coli*, the LAF containing 0% xanthan gum demonstrated significantly higher inhibition ($P<0.05$) against *L. innocua, L. monocytogenes* J1003, J129, *E. coli* O111, O157:H12, and O150:H8 when compared to 0.2% xanthan gum and PE-EVOH controls. While LAFs containing 0 and 0.2% XG significantly reduced ($P<0.05$) *E. coli* and *Listeria* spp. on raw beef and roast beef, as compared to EVOH controls, reductions between 0 and 2.5% XG were not seen across all treatments by day 28 (Figure 2).

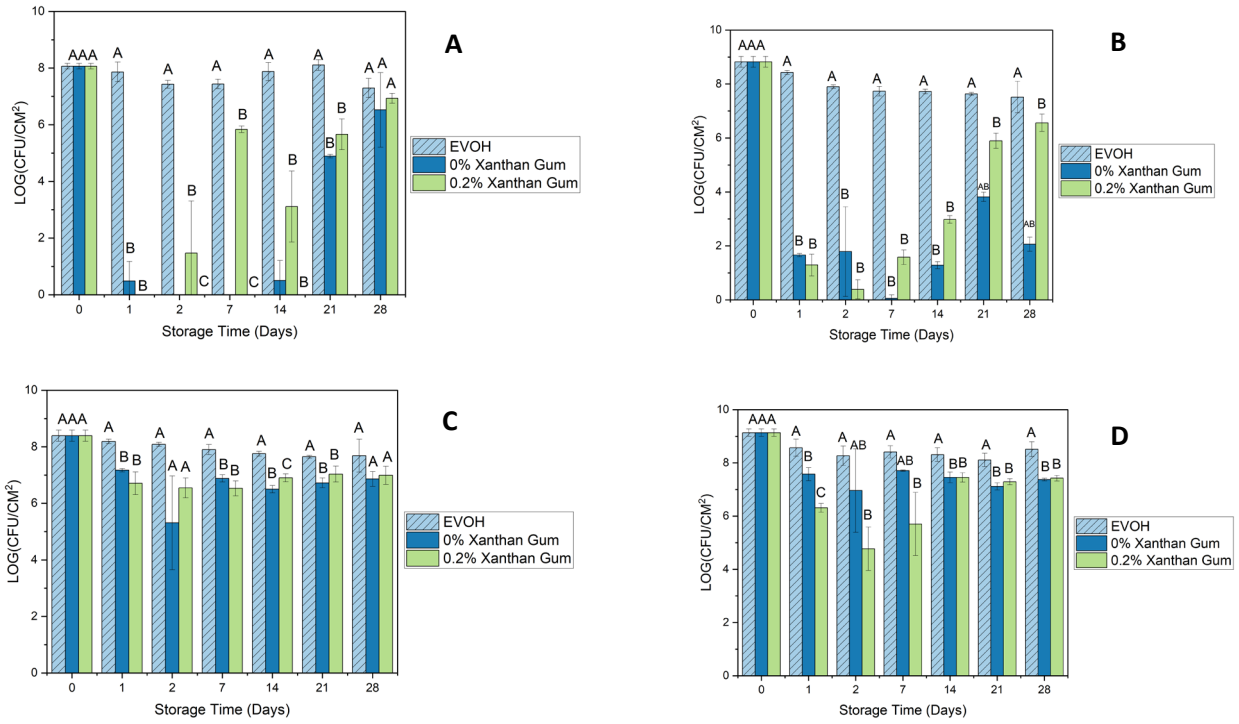

Figure 2**.** A. Growth of *Listeria spp*. on roast beef. B. Growth of *E. coli* on roast beef. C. Growth of *Listeria spp*. on beef eye round. D. Growth of *E. coli* on beef eye round after a 28-day storage period at 6°C. Results are presented in this section and the importance of the research area is discussed. ^{A,B,C} Means with the same letter at each storage time (day) are not significantly ($P<0.05$) different.

IV. CONCLUSIONS

This study demonstrates LAFs containing 0% XG exhibited increased antimicrobial activity against microorganisms in plate overlay assays, as compared to 0.2%. However, this activity was not observed throughout the challenge study. Protein, fat, added ingredients, and manufacturing processes can greatly impact the antimicrobial activity of LAE through electrostatic and hydrophobic interactions. Future research is needed to determine the impact of meat matrices on the antimicrobial efficacy of the LAF.

REFERENCES

1. Hassan, A. H., & Cutter, C. N. (2020). Development and evaluation of pullulan-based composite antimicrobial films (CAF) incorporated with nisin, thymol and lauric arginate to reduce foodborne pathogens associated with muscle foods. International journal of food microbiology 320: 108519.
2. Loeffler, M., McClements, D. J., McLandsborough, L., Terjung, N., Chang, Y., & Weiss, J. (2014). Electrostatic interactions of cationic lauric arginate with anionic polysaccharides affect antimicrobial activity against spoilage yeasts. Journal of applied microbiology 117: 28-39.