UNIVERSITY of GUELPH

COLLEGE of BIOLOGICAL SCIENCE

DEPARTMENT OF MOLECULAR AND CELLULAR BIOLOGY

Announcement:

All interested members of the university community are invited to attend the Final Oral Examination for the degree of ***Doctor of Philosophy*** *of*

CARLOS MARTINEZ SOTO

on Tuesday, April 23rd, 2024 at 9:30a.m. (SSC 1511)

Thesis Title: **DEVELOPMENT AND ENCAPSULATION OF A MULTI-RECEPTOR PHAGE COCKTAIL AGAINST *SALMONELLA* FOR POULTRY FOOD SAFETY AND MULTI-OMICS CHARACTERIZATION OF PHAGE RESISTANCE**

Examination Committee:

Dr. Emma Allen-Vercoe, Molecular and Cellular Biology (Exam Chair)
Dr. Hany Anany, Dept. of Agriculture and Agri-Food Canada
Dr. Loong-Tak Lim, Dept. of Food Science
Dr. Matthew Sorbara, Dept. of Molecular and Cellular Biology
Dr. Sylvain Moineau, Dept. of Biochemistry, Microbiology and Bioinformatics , Universite Laval (External Examiner)

Advisory Committee:
Dr. Cezar Khursigara (Adv)
Dr. Hany Anany (Co-Adv)
Dr. Loong-Tak Lim

Abstract: *Salmonella* is one of the most prevalent food-borne bacterial pathogens worldwide, causing human gastroenteritis. Using broad-host range lytic bacteriophages (phages) as biocontrol agents has recently emerged as a novel approach to enhance food safety. In this study, a multi-receptor broad host range *Salmonella* phage cocktail was formulated. The cocktail targets four receptors: O-antigen, BtuB, OmpC, and rough *Salmonella* strains. The host range, morphotype, receptor, infection kinetics, genome sequence, temperature and pH stability of all phages comprising the cocktail were characterized. The free phage cocktail treatment significantly reduced the counts of *Salmonella* on chicken skin at different temperatures. Furthermore, electrospinning was implemented to develop a phage-based bioactive packaging material for raw poultry. This technique generated electrospun poly(ethylene oxide) (PEO) nonwoven loaded with high concentrations of the phage cocktail. A biocontrol experiment using raw chicken meat demonstrated the antimicrobial properties of the phage-loaded nonwoven against *S.* Enteritidis. Lastly, a *S.* Enteritidis strain resistant to all phages in the cocktail was isolated and characterized using genomics, transcriptomics, proteomics, and phenomics. The impact at the genome, transcriptome, proteome, phenome, and resistome level is described in this study. This research demonstrates the potential of using phage cocktails to mitigate the risk of *Salmonella* contamination in poultry products. Additionally, it explores the application of encapsulated phages as adjunct components in packaging materials for raw poultry to inhibit *Salmonella* growth. Finally, it demonstrates the capacity

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of using multi-omics techniques to describe, predict, and assess the impact of phage resistance development.

Curriculum Vitae: Carlos obtained his Bachelor's degree in Biotechnology Engineering at the Sonora Institute of Technology, Sonora, Mexico in 2016. In 2018, he obtained his Masters degree in Genetics and Molecular Biology at the Center for Research and Advanced Studies of the National Polytechnic Institute, Mexico City, Mexico. In the summer of 2019 he entered into the Ph.D. program under the supervision of Dr. Cezar Khursigara and Dr. Hanay Anany.

Publications:

Martinez-Soto CE, Cucic S, Lin JT, Kirst S, Mahmoud ES, Khursigara CM, Anany H. PHIDA: A High Throughput Turbidimetric Data Analytic Tool to Compare Host Range Profiles of Bacteriophages Isolated Using Different Enrichment Methods. Viruses. 2021; 13(11):2120. https://doi.org/10.3390/v13112120

Islam, M.R., Martinez-Soto, C.E., Lin, J.T., Khursigara, C.M., Barbut, S., & Anany, H. (2021). A systematic review from basics to omics on bacteriophage applications in poultry production and processing. Critical reviews in food science and nutrition, 1-33. https://doi.org/10.1080/10408398.2021.1984200

Martinez-Soto, C. E.; McClelland, M.; Kropinski, A. M.; Lin, J. T.; Khursigara, C. M.; Anany, H., Multi-receptor phage cocktail against Salmonella enterica to circumvent phage resistance. microLife 2024, 5, uqae003. 10.1093/femsml/uqae003