Engineered Magnesium Oxide Microparticles for Targeted Gut Health and Disease Resistance

*Anjana Jayasree, Haochu Zhu, and Amirali Popat**

Centre for Environmental and Agricultural Solutions to Antimicrobial Resistance
School of Pharmacy and Pharmaceutical Sciences, The University of Queensland
Brisbane, Queensland, Australia
a.jayasree@uq.edu.au, a.popat@uq.edu.au

Antimicrobial resistance (AMR) is an escalating global challenge, necessitating the urgent development of alternative strategies to reduce reliance on traditional antibiotics. Metallic nanoparticles have emerged as promising candidates due to their broad-spectrum antimicrobial properties and potential for targeted delivery. Among these, magnesium oxide (MgO) has garnered significant attention for its bioactive properties, including antimicrobial efficacy and its essential role as a macromineral in metabolic functions[1]. However, conventional MgO supplementation is limited by poor bioavailability and potential gut irritation[2]. Our industry partner, Calix, utilizes a flash calcination technique to produce highly bioactive MgO microparticles with broad-spectrum antibacterial efficacy. This project aims to develop formulations using these MgO microparticles to enhance magnesium uptake, support gut health, and mitigate bacterial infections while reducing dependence on traditional antibiotics. Seven types of MgO compounds were obtained from Calix, and detailed characterization, including size (DLS), surface charge (zeta potential), and structure (SEM), revealed that these particles varied in size from 0.4 to 6 µm. The MgO particles will be screened against beneficial gut bacteria and pathogenic bacterial species, with nanoparticles demonstrating strong activity being selected for formulation development. MgO-based formulation strategies, including dietary fiber-based carriers and pH-responsive polymers, will be employed using the spray-drying technique to improve MgO bioavailability and targeted delivery in the gastrointestinal tract. These formulations will be optimized for controlled release and reduced gut irritation. Antibacterial efficacy will be assessed through disc diffusion and minimum inhibitory concentration (MIC) assays. An in vitro fermentation model will be used to analyze microbial modulation and metabolic activity. Finally, in vivo trials will be conducted to assess MgO absorption, gut microbiota modulation, and overall health benefits, including immune response and metabolic performance.

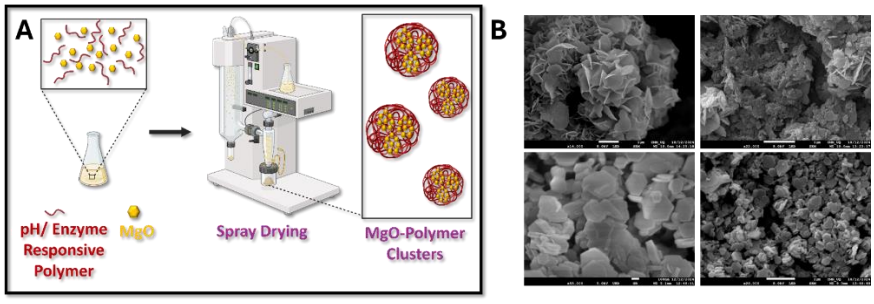

Figure 1: (A) Schematic representation of formulation of MgO Microparticles, (B) SEM of MgO particles

References:

[1] Lin J, Nguyen NT, Zhang C, Ha A, Liu HH. Antimicrobial Properties of MgO Nanostructures on Magnesium Substrates. *ACS Omega*. **2020**;5(38):24613-27.

[2] Omori K, Miyakawa H, Watanabe A, Nakayama Y, Lyu Y, Ichikawa N, et al. The Combined Effects of Magnesium Oxide and Inulin on Intestinal Microbiota and Cecal Short-Chain Fatty Acids. *Nutrients*. **2021**;13(1).