TECHNICAL BULLETIN

Maternal Zinc Status Influences Gut Health and Inflammatory Signaling During Pregnancy

Introduction

Zinc (Zn) is an essential trace mineral involved in immune function, gastrointestinal health, and neurological signaling. Zinc requirements are increased considerably during pregnancy, while dietary antagonists such as phytates, folic acid, calcium (Ca) and iron (Fe) may reduce Zn bioavailability despite adequate Zn consumption. This study evaluated how Zn deficiency and reduced Zn bioavailability affect gut microbiota composition, gastrointestinal (GI) barrier integrity and inflammatory signaling during pregnancy, and whether supplementation with Zn amino acid complexes (ZnAAs) could mitigate these effects.

Study Objective

To determine whether Zn deficiency or reduced Zn bioavailability during pregnancy alters gut microbiota composition, GI barrier integrity, and inflammatory signaling, and to evaluate the ability of ZnAA supplementation to alleviate any detrimental effects.

Experimental Models

- Pregnant C57BL/6 mice fed experimental diets for 8 weeks
- Zn-adequate and Zn-deficient diets
- Zn-adequate diet + antagonists (phytate, folic acid, Ca, Fe) with and without ZnAAs
- Gut microbiome profiling using 16S rDNA sequencing, evaluation of intestinal barrier markers, assessment of liver lipopolysaccharide (LPS) and measurement of inflammatory markers in brain tissue

Key Findings

1. **Low Zn Availability Reduces Zn Status During Pregnancy (Fig. 1)**
   - Zn-deficient diets reduced whole-blood Zn.
   - Diets with Zn-uptake antagonists produced similar reductions in Zn-status despite adequate dietary Zn levels.
   - Results show Zn bioavailability is as important as Zn intake in maintaining pregnancy Zn status.

2. **ZnAAs Supplementation Partially Restores Gut Health Markers (Fig. 2a-b)**
   - Zn + antagonist diets reduced *Proteobacteria* abundance compared to Control mice.
   - ZnAA supplementation partially restored *Proteobacteria* abundance toward Control levels.
   - Zn + antagonist diets increased zonulin-1, a marker associated with impaired gut barrier function.
   - ZnAA supplementation prevented the increase in zonulin-1 observed in mice consuming Zn + antagonists.

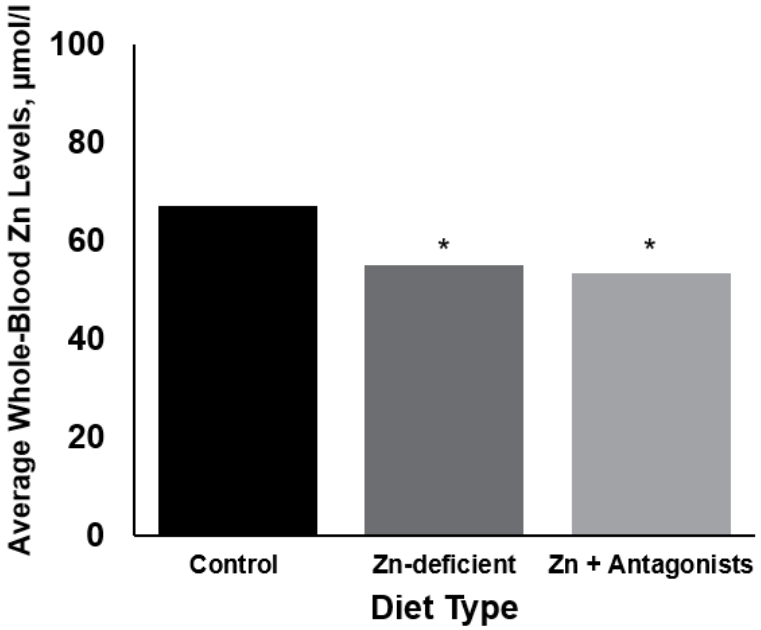


Figure 1. Reduced Zn Availability Lowers Whole-Blood Zn Status During Pregnancy

Zn-deficient and Zn + antagonist diets reduced whole-blood Zn concentrations in pregnant mice.

* $P < 0.05$

Data extrapolated from charts in publication

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Key Findings, Cont.

3. ZnAA Supplementation Reduced Markers of Barrier Dysfunction (Fig. 2c)

- Zn + antagonist diets increased liver LPS, indicating greater movement of bacterial products from the intestine into systemic circulation.
- ZnAA supplementation reduced liver LPS accumulation compared to Zn + antagonist diets alone.

4. ZnAA Supplementation Improves Outcomes Associated with Reduced Zn Availability

- ZnAA supplementation restored whole-blood Zn concentration towards Control levels.
- ZnAA supplementation partially normalized gut microbial composition.
- ZnAA supplementation improved markers of gut barrier function.
- ZnAA supplementation reduced markers associated with systemic inflammatory responses.

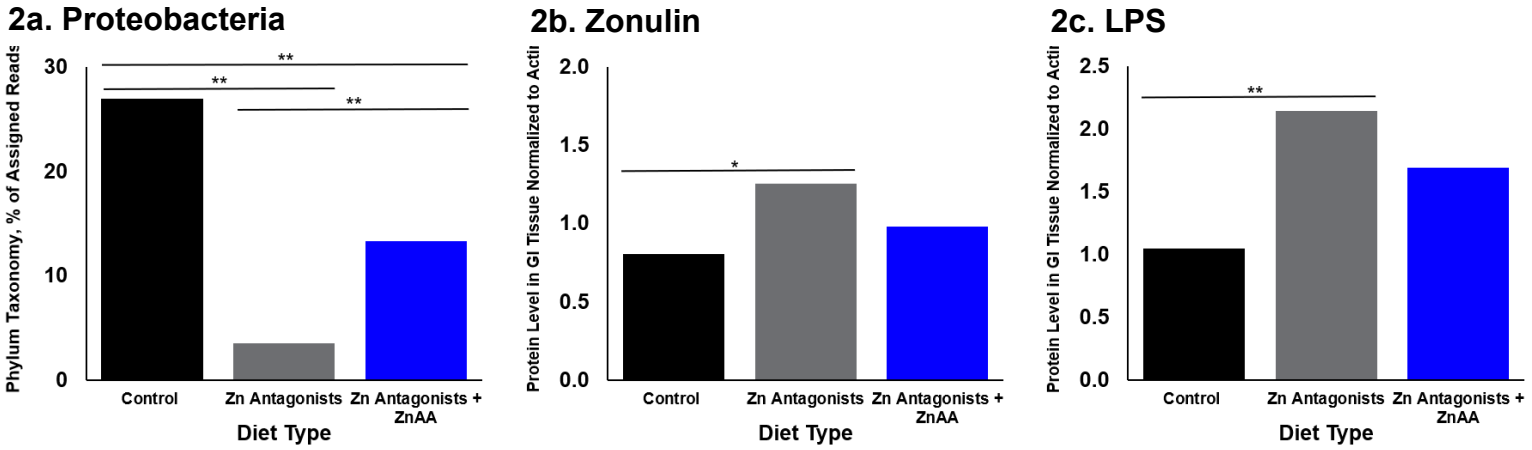


Figure 2a-c. ZnAA Supplementation Partially Restored Gut and Barrier Markers Altered by Reduced Zn Availability

Zn + antagonist diets altered microbial composition and increased markers associated with impaired gut barrier function. ZnAA supplementation partially restored microbiota composition and reduced indicators of barrier dysfunction and systemic inflammatory exposure.

* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Data extrapolated from charts in publication

Conclusion & Implication

Reduced Zn availability during pregnancy altered gut microbial composition, compromised markers of intestinal barrier integrity, and increased indicators of systemic inflammation in pregnant mice. Supplementation with ZnAA improved Zn status and partially restored microbiome, gut barrier, and inflammatory markers affected by reduced Zn availability.

Maintaining adequate Zn availability during pregnancy supports gut microbial balance, intestinal barrier function, and normal inflammatory responses. Dietary antagonists can reduce Zn bioavailability, making Zn source an important consideration when developing nutritional strategies to support maternal health.

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