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Zinc deficiency alters gut bacteria makeup and function

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A new study reveals that zinc deficiency – a condition that affects 25 percent of the world's population, especially in the developing world – alters the makeup of bacteria found in the intestine.

"We are the first to show that zinc deficiency has a significant effect on the microbial population and diversity in the intestine," said Elad Tako, a senior scientist physiologist at the U.S. Department of Agriculture's Robert W. Holley Center for Agriculture and Health and a courtesy food science professor at Cornell. Tako is the senior author of the paper recently published in the journal Nutrients.

The finding is important because previous studies have shown that many diseases and physiological conditions – including depression, diabetes, obesity and heart disease – have links to recognizable gut bacterial profiles.

The findings in this study suggest a simple new way to test for zinc deficiency by analyzing a patient's fecal sample and seeing if the profile of gut bacteria matches the makeup one would expect in a zinc-deficient individual. "With additional research, this can potentially be a completely noninvasive biomarker for zinc deficiency," Tako said.

The researchers used broiler chickens in the study, partly due to their omnivorous appetites – which allowed the researchers to feed them purified diets – and because of their fatty acids and genetic similarities to humans.

The researchers fed one group of chickens a diet with adequate amounts of zinc and another group with deficient zinc. They collected fecal samples from both groups, extracted microbial DNA and sent those to Dr. Omry Koren at the microbiome research laboratory at the medical faculty at Bar-Ilan University in Israel.

Koren used DNA sequencing to provide raw data of microbial profiles which Tako and first author Spenser Reed '14 analyzed for the study. Reed, was an undergraduate researcher in Tako's lab, and is currently a medical student at the University of Arizona.

In the zinc-deficient chickens, the bacterial profiles were less diverse, leading to reduced bacterial activity. Gut bacteria are important for a number of reasons, including breaking down nutrients in food into short-chain fatty acids, which increases gut acidity and contributes to digestion and the solubility of minerals, particularly iron and zinc. In zinc-deficient chickens, "the concentrations of key short chain fatty acids were lower, and this can potentially reduce the bioavailability of and hence absorption of zinc, which can basically contribute to or intensify the zinc-deficient status of a subject," Tako said.

In zinc-deficient chickens, the relative abundance of specific groups of gut bacteria were also found to increase, and these groups can possibly compete with the host for zinc, and may lead to further deficiency, Tako said.

The World Health Organization has identified iron and zinc deficiencies (which often go hand in hand) resulting from poor nutrition as a major global health issue. Plant breeders are working to biofortify crops, such as beans, with greater iron. So far, no crops with greater zinc have been developed.

Tako and colleagues are now studying the role of prebiotics, fibers in

staple food crops such as lentils that survive initial digestion that then ferment in the lower intestine and increase bioavailability of iron and zinc.

"This study opens the door into looking at how other nutritional traits might affect the intestinal microbiome," said Tako. He and his group are also conducting similar experiments to determine gut microbiota profiles for iron deficiency.

More information: Spenser Reed et al. Chronic Zinc Deficiency Alters Chick Gut Microbiota Composition and Function, *Nutrients* (2015). DOI: 10.3390/nu7125497

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