Nanoparticles in food packaging may disrupt gut function
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Zinc oxide nanoparticles are added to many different types of food packaging. A new study finds that these minute particles might disrupt the way that our intestines absorb nutrients.

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Nanoparticles are between 1 and 100 nanometers in diameter.

To put that into perspective, a human hair is around 75,000 nanometers across, and a red blood cell is roughly 7,000 nanometers across.

So, nanoparticles are very small indeed. And, worryingly, they are everywhere.

Nanoparticles have a relatively large surface area, which makes them more chemically reactive. This increased reactivity gives them unique properties that are utilized by the manufacturers of a vast range of products, including paints, cosmetics, windows, sunscreens, fabrics, and cars.

As nanoparticles are used ever more liberally, some scientists are becoming increasingly concerned about their potential impact on human health.

Because they are so common and so small, it is very easy for nanoparticles to enter our bodies. And, even more worryingly, they are small enough to pass through cell membranes, potentially disrupting their activity. However, little is known about how they might interfere with biological processes.

Looking to investigate these interactions, researchers from Binghamton University in New York looked at zinc oxide (ZnO) nanoparticles in food packaging in particular.

Why is zinc in food packaging?

ZnO nanoparticles are included in the packaging of certain food items, such as corn, chicken, tuna, and asparagus, because they have antimicrobial properties. Also, when sulfur-producing foods come into contact with a tin can, it produces a black discoloration; ZnO prevents this reaction, keeping the food fresh-looking.

The researchers — led by Gretchen Mahler, an associate professor of bioengineering — wanted to understand whether the levels present in the food could cause disruptions to the digestive system.

Firstly, using mass spectrometry, they assessed how much ZnO could realistically be transferred from the packaging into the food.

The food was found to contain "100 times the daily dietary allowance of zinc."
Previous studies have investigated the effect of nanoparticles on intestinal cells, but they tended to use higher levels to look for more obvious damage, such as cell death. Mahler and her team were using a different approach.

She explains, "We are looking at cell function, which is a much more subtle effect, and looking at nanoparticle doses that are closer to what you might really be exposed to."

Using a model of intestinal cells, the team assessed what kind of influence the ZnO nanoparticles might have on our intestines. Their results are published in the journal *Food and Function*.

Mahler explains what they uncovered:
"We found that [ZnO] nanoparticles at doses that are relevant to what you might normally eat in a meal or a day can change the way that your intestine absorbs nutrients."

Zinc nanoparticles and microvilli
The particles were observed settling on structures that represent the intestine's microvilli. These are tiny, finger-like projections that increase the surface area of the intestine that is available for nutrient absorption. By attaching to the microvilli, the nanoparticles potentially reduced the ability of the lining to take on nutrients. "This loss of surface area," explains Mahler, "tends to result in a decrease in nutrient absorption." "Some of the nanoparticles also cause pro-inflammatory signaling at high doses, and this can increase the permeability of the intestinal model," she adds.

"An increase in intestinal permeability is not a good thing — it means that compounds that are not supposed to pass through into the bloodstream might be able to."
- *Gretchen Mahler*

Although this certainly seems worrying, the authors are quick to note that this study was conducted in the laboratory, rather than in an animal. Thus, at this stage, the findings cannot be extrapolated. To fully understand the long-term health implications, much more research will be needed. However, she concludes:

"What I can say is that our model shows that the nanoparticles do have effects on our in vitro model, and that understanding how they affect gut function is an important area of study for consumer safety."

Already, the team is investigating the effects of nanoparticles on other animals. A paper published last month in the journal *Nanotoxicology* looked at how titanium dioxide nanoparticles — which are found in many cosmetics — affect the gut of a fruit fly. Again, they found changes in microvilli, which affected glucose absorption.

In another ongoing study in chickens, Mahler says that preliminary findings are "similar to the cell culture study" discussed in this article. They have also found that "gut microbial populations are affected," which opens a whole new line of inquiry.

The team now plans to continue in this vein and will be concentrating its efforts on the potential interaction between nanoparticles and gut bacteria.

References
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