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As Levels of This Widespread Toxin Soar, so Does Disease

Analysis by Dr. Joseph Mercola ✔ Fact Checked | May 08, 2022

STORY AT-A-GLANCE

- Stephanie Seneff, a senior research scientist at the Massachusetts Institute of Technology, has been studying glyphosate for years and has become hooked on determining what makes this ubiquitous chemical so toxic
- One of the ways glyphosate may be harmful is via disruption of glycine homeostasis; glycine is a very common amino acid your body uses to make proteins
- Glyphosate also inhibits the shikimate pathway, which is involved in the synthesis of the essential aromatic amino acids phenylalanine, tyrosine and tryptophan
- Glyphosate also causes sulfate deficiency and impairs the heme pathway
- Eating organic, consuming organic, unpasteurized apple cider vinegar, eating garlic and cruciferous vegetables, and glycine supplementation (or consuming organic bone broth) can help protect you from glyphosate toxicity

This article was previously published August 4, 2019, and has been updated with new information.

Glyphosate, the active ingredient in Roundup herbicide, is a chemical worthy of attention, in part because no other pesticide or herbicide has come even close to its "intensive and widespread use."[1] The data on just how much glyphosate is sprayed in the U.S. is mind boggling, and adds up to over 1.6 billion kilograms (3.5 billion pounds) applied since 1974.

This represents 19% of the glyphosate used globally during that time, and the majority (two-thirds of glyphosate applied from 1974 to 2014) was applied in just 10 years.[2] Glyphosate should catch your attention because it's turning up virtually everywhere — in breastmilk, water,[3] disposable diapers[4] and honey, for starters.

It caught the attention of Stephanie Seneff, a senior research scientist at the Massachusetts Institute of Technology, for another reason entirely.

I caught up with Seneff at an autism event in Atlanta, Georgia, called The Autism Community in Action (TACA). She's been a champion for helping to understand how glyphosate is an issue, and she presented some of her new findings at the conference, where I recorded the interview above.

Seneff has been studying glyphosate for years and has become hooked on determining what makes this ubiquitous chemical so toxic:

> *"Glyphosate is an absolutely fascinating molecule. I've become hooked on it so to speak. And I just love the research; I love the puzzle. And glyphosate is the mother of all puzzles in my opinion. I believe I'm zeroing in on the mechanism of toxicity, and it's unique to glyphosate, and insidious and cumulative.*
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> *So, it's extremely dangerous in the sense that it doesn't bowl you over. You get small exposures to glyphosate all day long in your food, in the air, in the water, probably breathing the air from the gasoline tank. We don't know. But it's pervasive in the environment so we can't avoid it. And the United States has the highest … we use the most glyphosate per person per capita in this country."*

Is Glyphosate Causing Chronic Diseases?

According to Seneff, the increase in glyphosate usage in the U.S., as well as in Canada, is extremely well correlated with the concurrent increase in the incidence of multiple diseases, including breast cancer, pancreatic cancer, kidney cancer, thyroid cancer, liver cancer, bladder cancer and myeloid leukemia.[5]

"[B]oth of those countries have a lot of heart health issues, high Autism rates, lots of autoimmune diseases, food allergies; Alzheimer's is going up dramatically. Of course, diabetes, obesity, all these things are going up dramatically in our population," Seneff says.

"We don't know why. We see that glyphosate is perfectly correlated with many of these diseases. It's also going up exactly in step with these diseases, and there's many, many plots that I've put together in collaboration with other people."

Research scientist Anthony Samsel is one of Seneff's coauthors, and together they've suggested that one of the ways glyphosate is harmful is via disruption of glycine homeostasis. Glyphosate has a glycine molecule as part of its structure (hence the "gly" in glyphosate). Glycine is a very common amino acid your body uses to make proteins.

Samsel and Seneff believe your body can substitute glyphosate and its metabolite aminomethylphosphonic acid (AMPA) into peptides and proteins, which results in damaged peptides and proteins being produced. According to Seneff:

"I believe that in certain proteins, in certain spots, glyphosate is able to get into the protein by mistake in place of the amino acid glycine. And, to understand that glyphosate is a complete glycine molecule, it's a perfect match to glycine, except that it has extra materials stuck onto its nitrogen atom.

… [T]he protein that's going to recognize glycine in order to put it into DNA has to leave the nitrogen atom outside of its pocket because the nitrogen has to hook up with the next amino acid. So, the fact that the nitrogen has some stuff on it doesn't matter to it. It says, 'Oh, I have to fit exactly glycine very tightly.'

Glycine is the smallest amino acid. And in order to distinguish glycine from all the other amino acids all I need to do is make sure that I make a tiny space that fits only glycine …

> *Glyphosate will fit because it's a perfect glycine molecule. Except the nitrogen is sticking outside of that pocket so that it could hook. So the extra stuff on nitrogen is not constrained. This is important because I think a lot of people think, 'Oh, it can't happen.'"*

Glycine also plays a role in quenching inflammation, and is used up in the detoxification process. As a result of glyphosate toxicity, many of us may not have enough glycine for efficient detoxification.

That being said, glyphosate causing glycine disruption is a highly controversial issue, as it's theoretical in nature, not proven. But, it makes a lot of sense, in part due to the shikimate pathway.

Seneff also addresses glyphosate as a glycine analogue, and how it gets incorporated into proteins by mistake, in her paper,[6] "Glyphosate's Synergistic Toxicity in Combination with Other Factors as a Cause of Chronic Kidney Disease of Unknown Origin," published in the International Journal of Environmental Research. This paper also offers support for many of the statements made by Seneff in this interview.

Glyphosate Disrupts the Shikimate Pathway

Glyphosate inhibits the shikimate pathway, which is involved in the synthesis of the essential aromatic amino acids phenylalanine, tyrosine and tryptophan.[7]

"Super, super important," Seneff says. "[These amino acids are] … not only part of the building blocks of proteins which would already be pretty drastic, but they're also precursors to all the neurotransmitters. Dopamine, serotonin, melatonin, melanin. Skin tanning agent. They're also precursors to certain B vitamins like folate and I think niacin."

While the shikimate pathway is absent in human and animal cells, this pathway is present in the gut bacteria of mammals, including humans. So, by way of your gut bacteria, glyphosate wields a significant influence on human health. For instance, Seneff

says, "Sleep disorder is one of the diseases that's going up exactly in step with glyphosate usage on corn crops, because of the melatonin problem I suspect, in part."

In addition, glyphosate moves to both the growing points and storage structures (including roots and seeds) of plants to target EPSP synthase, which prevents production of certain amino acids and diverts energy from essential plant processes. This is a key point as far as glycine disruption goes. Seneff says:

> *"… [I]t makes more and more sense the more I study, first of all, from the standpoint of which enzymes get disrupted by glyphosate.*
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> *And, I can find these glycine places where it would substitute in a cell, including, of course, EPSP synthase, which is the enzyme that … I started with … because EPSP synthase is the enzyme in the shikimate pathway that glyphosate disrupts, famously disrupts. They know that. And they've studied it. There's lots of papers on it. It's very, very interesting."*

The Glycine and Myosin Connection

So, according to Seneff, glyphosate is basically a glycine molecule with a side chain attached to the nitrogen atom, and even though it's a modified glycine molecule, it's still glycine. This is why it can replace the regular amino acid glycine in your system. Unfortunately, it's now toxic.

"Getting back to this EPSP synthase," Seneff says, "it's really fascinating … the way they discovered the version of EPSP synthase that they insert into the GMO crops … so they make these Roundup Ready crops glyphosate-resistant. And they do that by inserting a bacterial version of EPSP synthase … and that bacterial version has alanine instead of glycine at that spot."

To understand why this is so important, certain proteins must have glycine in order to work properly. If you change the glycine into alanine by adding one extra methyl group, it ruins the protein. Seneff mentions a recent paper by DowDuPont, which talks about

using CRISPR gene-editing technology to make plants glyphosate resistant by tweaking glycine residue.[8]

"This is absolutely terrifying," Seneff says. "They knew, 'First we've got to get rid of glycine.' And then that takes a hit on the enzyme. The enzyme doesn't work as well because it's got alanine there. It's got that extra methyl group that's in the way, the same problem that glyphosate causes."

Myosin, in turn, is a good example of a protein that needs glycine to work properly, which could be disrupted by glyphosate. Myosin is an important contractor protein to move the feces through the gut, but if it gets mutated it can no longer contract. Seneff adds:

> *"[I]f myosin gets paralyzed you're going to get peristalsis. You're going to get small intestinal bacterial overgrowth (SIBO) because things get backed up. You get a lot of problems with your gut because the myosin is not able to contract. You get constipation of course. And these are all connected to autism, these problems.*
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> *And so I think the myosin in the gut is being poisoned by the glyphosate in the same way that the EPSP synthase in the shikimate pathway is being poisoned. Because of this glycine at this place where phosphate is supposed to bind sets up a beautiful environment for throwing glyphosate in place of glycine in the protein itself."*

Glyphosate also causes sulfate deficiency "in so many ways," Seneff says, "it's almost like it's a perfect storm," and impairs the heme pathway.

Solutions for Glyphosate Toxicity

As the realities of glyphosate toxicity grow, there are steps you can take to protect yourself, starting with limiting your exposure by eating organic or biodynamically grown food as much as possible. Consuming organic, unpasteurized apple cider vinegar is another strategy, as it contains acetobacter, which can break down glyphosate.

"We make salad dressing [with apple cider vinegar]," Seneff says. "We have salad for dinner and I think it can actually help you to break down whatever glyphosate is in your mouth, because it will get right to work turning glyphosate into useful phosphorous. It completely gets rid of it."

Seneff also suggests eating garlic and cruciferous vegetables, which are good sources of sulfur. Glycine supplementation may also be a good option to help detoxify glyphosate. To eliminate glyphosate, you need to saturate your body with glycine.

Dr. Dietrich Klinghardt, who is a specialist in metal toxicity and its connection to chronic infections, recommends taking 1 teaspoon (4 grams) of glycine powder twice a day for a few weeks and then lower the dose to one-fourth teaspoon (1 gram) twice a day. This forces the glyphosate out of your system, allowing it to be eliminated through your urine.

Collagen is naturally rich in glycine, but if going this route, I recommend looking for organic grass fed collagen only. Organic bone broth is another excellent source of glycine-rich collagen.

Sources and References

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