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Even Low Levels of Glyphosate Alter Your Gut Microbiota

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STORY AT-A-GLANCE

- Gut microbiota composition was significantly impacted when mice were exposed to glyphosate at levels approximating the U.S. Acceptable Daily Intake of 1.75 mg/kg of body weight
- Proinflammatory T cells and Lipocalin-2, a marker of intestinal inflammation, increased after low-dose glyphosate exposure
- Low-dose glyphosate exposure also reduced the abundance of beneficial bacteria, including Bifidobacterium pseudolongum and Lactobacillus sp in the gut
- Low levels of glyphosate also decreased microbial short-chain fatty acid (SCFA) biosynthesis pathways, an adverse effect, since SCFAs modulate gene expression, leading to increases in beneficial anti-inflammatory regulatory T cells
- You can reduce your exposure to glyphosate by eating organic foods; saturating your body with glycine may help provide some protection from glyphosate toxicity

About 8.6 billion kilograms of glyphosate, equivalent to about 18.9 billion pounds, have been applied to agricultural fields and other land worldwide since 1974. The majority — up to two-thirds — was used in the last decade.[1]

Glyphosate is a key ingredient in herbicides like Roundup, which in its earlier days was advertised as "biodegradable" and "environmentally friendly." Monsanto even went so far as to claim it "left the soil clean" — until they were found guilty of false advertising because the chemical is actually dangerous to the environment.[2]

It's toxic to humans, too, and is capable of altering gut microbiota, among other health risks. Perhaps most concerning of all, given that glyphosate has been widely detected in food and water, these changes occur even at low levels of exposure.

Low-Dose Exposure to Glyphosate Disrupts Gut Homeostasis

A team of University of Iowa researchers exposed mice to glyphosate at levels approximating the U.S. Acceptable Daily Intake of 1.75 mg/kg of body weight. When their fecal samples were analyzed, they found the exposure "significantly impacts gut microbiota composition," including altering gut homeostasis. Proinflammatory T cells and Lipocalin-2, a marker of intestinal inflammation, increased after low-dose glyphosate exposure.[3]

Glyphosate kills plants by inhibiting the 5-enolpyruvylshikimate-3 phosphate synthase (EPSPS) enzyme. EPSPS is an enzymatic step in the shikimate pathway,[4] which is involved in the synthesis of the essential aromatic amino acids phenylalanine, tyrosine and tryptophan.[5]

Since mammals do not have the shikimate pathway, it was suggested that glyphosate would not affect human health. However, some microorganisms do have the shikimate pathway, and it's via this link that many of glyphosate's adverse effects in humans may occur. According to the study:[6]

> *"Trillions of bacteria (gut microbiota) living in the human gut play a critical role in maintaining the healthy state of the human through the regulation of several host physiological processes, including the development and maintenance of the immune, endocrine, and nervous systems.*
>
> *As bacteria utilize the shikimate pathway, glyphosate could alter gut microbiota composition by inhibiting gut bacteria harboring glyphosate sensitive EPSPS enzymes. Multiple in vitro studies have verified that many gut resident microbes are sensitive to glyphosate exposure."*

In addition to increasing fecal pH levels and proinflammatory markers, the study found low-dose glyphosate exposure reduced the abundance of beneficial bacteria, including Bifidobacterium pseudolongum and Lactobacillus sp. It also decreased microbial short-chain fatty acid (SCFA) biosynthesis pathways, an adverse effect, since SCFAs modulate gene expression, leading to increases in beneficial anti-inflammatory regulatory T cells.[7]

In short, the team explained, "We found that glyphosate exposure, at doses similar to the U.S. ADI, can alter gut microbiota composition and modulate the neuro-immune-endocrine system resulting in a proinflammatory environment."[8]

Glyphosate May Disrupt Glycine Homeostasis

Stephanie Seneff, a senior research scientist at the Massachusetts Institute of Technology (MIT), has been studying glyphosate for years and has been a champion for helping to understand how and why glyphosate is so dangerous.

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.[9]

Research scientist Anthony Samsel is one of Seneff's co-authors, 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 as she explains in the video above:

> *"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.

… the 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.'"

Going back to EPSPS, the bacterial version of EPSPS inserted into glyphosate-resistant Roundup Ready crop has alanine instead of glycine. But, according to Seneff, if you change the glycine into alanine by adding one extra methyl group, it ruins the protein.

"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."

The arguments for why glyphosate specifically disrupts proteins that depend on glycine for phosphate binding are described more fully in a paper Seneff published together with colleagues arguing that glyphosate is a major factor in kidney failure among young agricultural workers in Central America.[10]

The Deuterium Connection

Deuterium is a naturally occurring isotope of hydrogen. Provided your cell is healthy, it has deuterium-depleting enzymes and organelles that help remove deuterium from your cells. If your mitochondria are damaged by glyphosate, they're not going to be able to eliminate the deuterium properly. This is another way glyphosate contributes to chronic disease, Seneff says.

Your cells are surrounded by structured water, which is negatively charged and contributes to your body's energy production by supplying deuterium-depleted hydrogen to lysosomes and mitochondria. The structured water is maintained by sulfates, which makes sulfate extremely important for health.

Deuterium is everywhere, naturally, but your body has developed an intricate way to make it harmless by trapping it in the structured water, where it's beneficial, as it actually supports the creation of structured water.

Problems arise when you cannot make enough structured water to sequester it all. Then, the deuterium gets loose, causing mitochondrial dysfunction, impairing energy production and contributing to chronic disease.

Glyphosate, however, makes sulfate dysfunctional, which in turn destroys structured water, resulting in impaired energy production in the cell.[11] The process is complex, but it's important for understanding how and why glyphosate is such a pernicious and insidious toxin. Seneff explains more about deuterium and how glyphosate contributes to its buildup in your body in our video interview above.

Glyphosate Linked to Liver, Kidney Diseases

Since at least 2014, published papers have exposed a link between glyphosate exposure and chronic kidney disease of unknown etiology (CKDu) in Sri Lankan farmers.[12] It's been suggested that consumption of glyphosate-contaminated water may contribute to chronic kidney disease by facilitating the transport of heavy metals such as arsenic and cadmium into the kidneys.[13]

In 2019, researchers again named agricultural chemicals, including glyphosate and paraquat, as possible primary factors in CKDu, noting, "[G]lyphosate causes insidious harm through its action as an amino acid analogue of glycine, and … this interferes with natural protective mechanisms against other exposures."[14]

A number of animal studies have linked glyphosate to liver damage as well, including one that dates back to 1979, which showed the chemical could disrupt mitochondria in rat livers.[15]

Glyphosate is also known to trigger the production of reactive oxygen species, leading to oxidative stress. As noted in Scientific Reports, "Elevation in oxidative stress markers is detected in rat liver and kidney after subchronic exposure to GBH [glyphosate-based herbicides] at the United States permitted glyphosate concentration of 700 μg/L in drinking water."[16,17]

Researchers from King's College London also showed an "ultra-low dose" of glyphosate-based herbicides was damaging in rats, leading to signs of non-alcoholic fatty liver disease.[18] People living agricultural regions, like Salinas Valley, California, may be particularly at risk.

In a study of children in Salinas Valley, exposure to glyphosate and its degradation product aminomethylphosphonic acid (AMPA) was found to increase the risk of liver and cardiometabolic disorders in early adulthood, which could trigger the development of additional diseases later in life, including liver cancer, diabetes and heart disease.[19]

Glyphosate Is Virtually Everywhere — How to Avoid It

More than 80% of U.S. children and adults, ages 6 years and up, have detectable levels of glyphosate in their urine, according to data from the U.S. Centers for Disease Control and Prevention.[20,21] Out of 2,310 urine samples that were collected as part of the National Health and Nutrition Examination Survey (NHANES), 1,885 contained glyphosate levels at or above the detection limit.

Even if you don't live near an agricultural area or use glyphosate-containing herbicides in your garden, you're likely being exposed via contaminated food and water. Fruits, fruit juices, vegetables, oatmeal and cereals are all likely sources of glyphosate in your diet.[22]

The use of glyphosate as a desiccant (drying agent) may be particularly problematic because it's sprayed so near to harvest, which could result in higher residue levels and greater exposures to consumers.[23] In 2020, food giant Kellogg announced they're phasing out the use of glyphosate as a desiccant by 2025,[24] but many other food manufacturers are still using this toxic chemical.

You can reduce your glyphosate exposure by primarily consuming organic foods. If you're wondering what your levels are, HRI Labs has developed home test kits for both water and urine, available in my online store. I do not make a profit from the sale of these kits. I only provide them as a service of convenience.

The urine test kit reveals the amount of glyphosate you've been exposed to in the past two to three weeks, while the hair test shows accumulated exposure over the past three to four months.

If your levels are high, fermented foods, particularly kimchi, are potent chelators of these kinds of chemicals. Taking activated charcoal after a questionable meal can help bind and excrete chemicals as well. Remember to stay well-hydrated to facilitate the removal of toxins through your liver, kidneys and skin.

Glycine supplementation may also be a good option to help detoxify glyphosate, because 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 lowering 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. Considering glycine has additional benefits for longevity and disease prevention, this is a solid strategy for protection.

There are a wide variety of other uses for glycine, which is why I take about 15 grams every day, primarily with protein like eggs and beef as it rebalances the methionine to glycine ratio to decrease methionine's negative impacts on your metabolism.

Additionally, you can use organic, grass-fed collagen, which is naturally rich in glycine. You can boost your collagen intake by making homemade bone broth using bones and connective tissue from grass-fed, organically raised animals, enjoying health benefits and helping reduce your glyphosate load at the same time.

Sources and References

- [1, 3, 4, 6, 7, 8] Environmental Toxicology and Pharmacology June 2023, Volume 100, 104149
- [2] BBC October 15, 2009
- [5, 9] Journal of Biological Physics and Chemistry January 2015, 15(3):121-159
- [10] Journal of Environmental Research and Public Health 2019, 16, 2734
- [11] Seneff and G Nigh. Sulfate's Critical Role for Maintaining Exclusion Zone Water: Dietary Factors Leading to Deficiencies. Water 2019; 11: 22-42
- [12, 13] Int J Environ Res Public Health. 2014 Feb; 11(2): 2125–2147
- [14] Int J Environ Res Public Health. 2019 Jul 31;16(15). pii: E2734. doi: 10.3390/ijerph16152734
- [15] Environ. Contam. Toxicol. (1979) 22: 357
- [16, 18] Scientific Reports January 9, 2017
- [17] Environmental Toxicology and Pharmacology November 2012, Volume 34, Issue 3, Pages 811-818
- [19] Environmental Health Perspectives March 1, 2023
- [20] U.S. CDC, National Health and Nutrition Examination Survey, Glyphosate in Urine June 2022
- [21] Substack, Carey Gillam, UnSpun July 9, 2022
- [22] U.S. CDC, Diet Is a Factor in Contact With Glyphosate
- [23] Environmental Health News October 30, 2017
- [24] Kellogg's Open for Breakfast