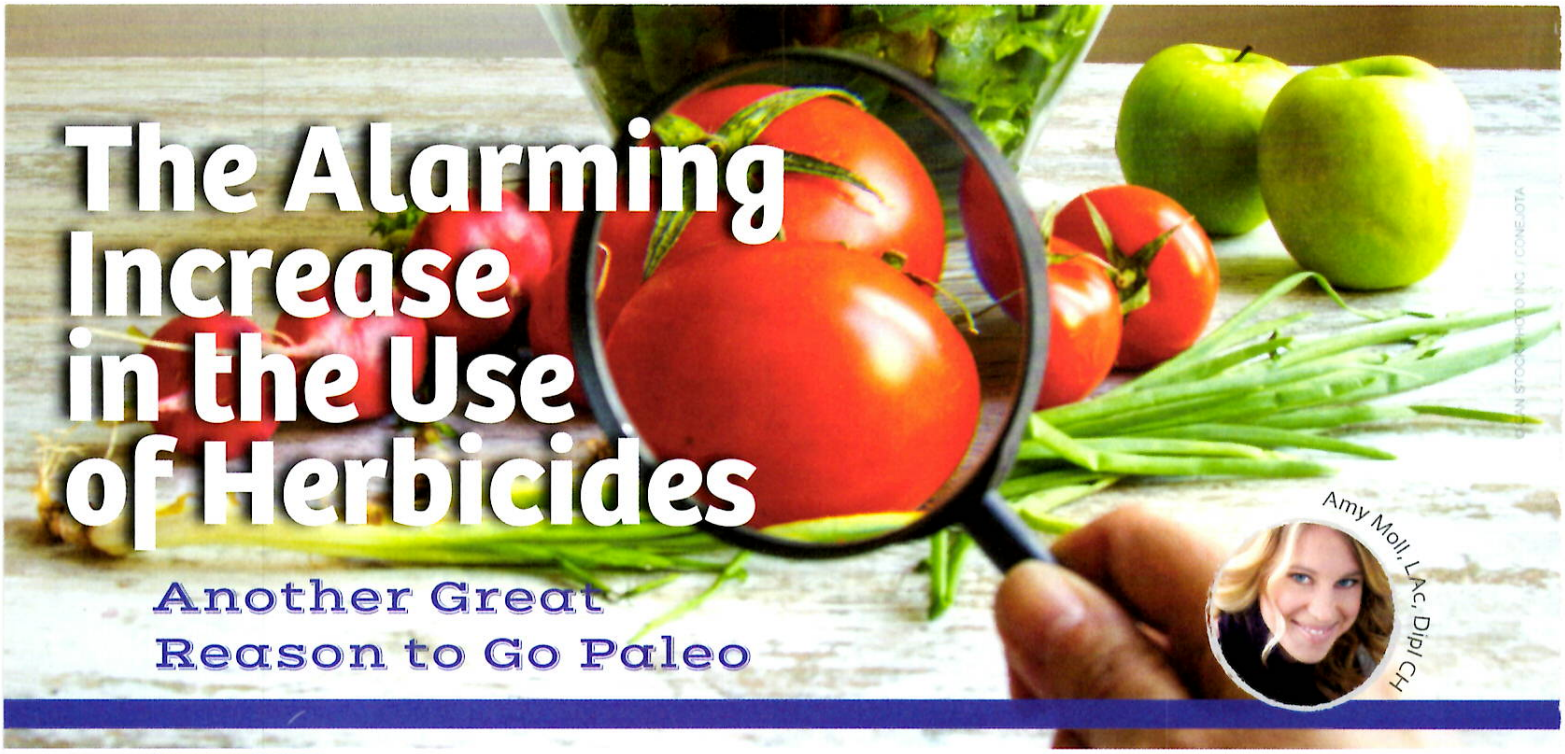

The Alarming Increase in the Use of Herbicides

Another Great Reason to Go Paleo

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Paleo enthusiasts may assume that their diets are free of unwanted agrochemicals. However, when 300 million pounds of glyphosate-based herbicides are used each year on American crops, they become hard to avoid.

In May, the World Health Organization's International Agency for Research on Cancer identified glyphosate, the main ingredient in the herbicide RoundUp (Monsanto), as "probably carcinogenic in humans."[1] Sri Lanka and El Salvador banned the import and use of all glyphosate-based herbicides after research studies identified them as the cause of a fivefold increase in chronic kidney disease in young farm workers. Bermuda blocked further importation of the chemical, and the Netherlands no longer allows sale for residential use.

Meanwhile, as more weeds become RoundUp resistant, the use of glyphosate-based herbicides in the United States continues to increase annually. Despite worldwide concerns for fish, wildlife, endangered species and human health, the U.S. government continues to pass laws in support of agrochemicals. In fact, the Environmental Protection Agency recently *increased* the allowable amount of glyphosate residues found in various foods and animal feed.[2]

Glyphosate: It's on the Cat, It's in Your Hat

Glyphosate-based herbicides are sprayed on crops to kill weeds, grasses, fungi and bacteria that would otherwise interfere with crop yields. Oats, corn, soy, wheat, rice, beans, seeds, peas, sweet potatoes and sugar cane are often sprayed with glyphosate just before harvest. This popular practice, called crop desiccation, greatly increases the amount of herbicide residue in the food supply.[2]

Exposure to glyphosate comes not only from farming. In 2007, residential use accounted for 5 to 8 million pounds, while commercial, industrial and government use accounted for approximately 15 million pounds. For example, glyphosate is often sprayed on urban sidewalks, parks, ponds and commercial lawns, to avoid weed overgrowth.[4] Glyphosate is now found in increasingly detectable levels in many facets of the environment, including the atmosphere, soil, groundwater, rainwater and surface waters. Herbicide residues are now found in detectable levels in humans, pets and homes.[5] Completely avoiding the massive environmental contamination from these chemicals is becoming nearly impossible.

RoundUp contains other chemicals, such as surfactants, that enhance the activity of glyphosate by allowing it to penetrate farther into the plant. The health concerns regarding exposure to herbicides are not simply about the toxicity of glyphosate, but rather, the combination of chemicals in products like RoundUp, and how they interact with pesticides and other additives present in the food supply. Epidemiologists are correlating the alarming use of glyphosate and its adjuvant chemicals with increased incidence of autism, celiac and cancers of the kidneys, bladder and thyroid. Deaths associated with kidney failure, Alzheimer's and Parkinson's were also closely correlated.[2]

While there is certainly not a single smoking gun to blame for cancers and neurological diseases, these correlations are supported by a functional medicine understanding of the effects these environmental toxins have on gut health, nutrient absorption, liver function, endocrine systems, detoxification pathways, bile acid synthesis, neurotransmitter production, inflammatory pathways and immune system modulation.[3]

To lay the foundation for how glyphosate could play a role in some of these diseases, three specific consequences of glyphosate exposure are reviewed here: gut dysbiosis; nutrient deficiencies; and the subsequent effects on brain health and cognition.

Gut Dysbiosis and Antibiotic Resistance

Glyphosate is designed to kill bacteria growing on plants and in the soil, but it also kills bacteria in the gut that are essential for optimal health. Animal studies in chickens, pigs and cattle have shown that glyphosate causes harm to *Lactobacillus*, *Bifidobacterium* and *Enterococcus* strains. These are the same beneficial species of bacteria that live in the human gut, so it is no giant leap of reasoning to understand how chronic exposure to glyphosate residues in food can become toxic to the human gut microbiome.

One in vitro study (by Shehata et al.) found RoundUp to be highly toxic to *Bifidobacterium* species.[6] *Bifidobacteria* and other probiotics are needed to maintain a healthy pH throughout the

gut and prevent overgrowth of pathogenic bacteria such as *Escherichia coli*, *Staphylococcus aureus*, *Clostridium difficile*, *Candida albicans* and *Salmonella spp*. Antibiotic-resistant strains of *Clostridium difficile* are becoming increasingly problematic, with the incidence of infections and associated death rates steadily on the rise in the past decade.[7] Many of the pathogenic bacteria in the Shehata study, including *Escherichia coli* and *Salmonella*, were found to be highly resistant to RoundUp.[6]

In a new line of inquiry regarding antibiotic resistance, research published this year showed certain strains of pathogenic bacteria had increased resistance to the antibiotics ciprofloxacin and kanamycin in the presence of RoundUp. Upon completion of the study, the researchers stated, "To address the crisis of antibiotic resistance requires broadening our view of environmental contributors to the evolution of resistance."[5] The implications of these actions are far reaching.

Vitamin, Mineral and Amino Acid Deficiencies

Glyphosate can lead to deficiencies of vitamins, minerals and amino acids through multiple mechanisms. Beneficial bacteria are necessary in order to absorb and synthesize vitamins such as folate, vitamin B12 and vitamin K. Deficiencies in these micronutrients can result from glyphosate's antimicrobial actions on gut bacteria. Vitamin D synthesis can also be affected. Glyphosate has been shown to inhibit cytochrome P450 (CYP) enzyme pathways essential for healthy liver function. Interfering with these enzymes impairs the conversion of vitamin D into its active form, 25-hydroxyvitamin D. Glyphosate binds to numerous minerals, including magnesium, iron, manganese, molybdenum and cobalt. This means that not only are crops depleted of these macro and trace minerals before they make it to the dinner table, but they can also be pulled out of the body as glyphosate moves through the system and is excreted through urine.[3]

Glyphosate's herbicidal actions on plants also lead to deficiencies of the amino acids phenylalanine, tyrosine, tryptophan, methionine, serine and glycine.[3] Methionine plays an important role in the production of thyroid hormones. Tryptophan, along with folate, vitamin B12 and magnesium, is a cofactor needed to make serotonin. These deficiencies, paired with inadequate amounts of beneficial bacteria, lead to reduced synthesis of 5-hydroxytryptophan (5-HTP) and serotonin. Serotonin produced in the gut plays a role in gastric motility, pain thresholds and peripheral blood flow. In the brain, 5-HTP is utilized to synthesize serotonin, and serotonin is required to produce melatonin. It is through an understanding of these functional relationships between bacteria, vitamins, minerals, amino acids and neurotransmitters that one can start to see the downstream effects that chronic exposure to an antimicrobial such as glyphosate can have on a system.

Gut Dysbiosis and Brain Health

The impact of pathogenic bacterial overgrowth goes beyond the gut, and can negatively affect the brain. Gut dysbiosis is now being linked to depression, anxiety, insomnia, autism, and cognitive disorders.[8] By activating the signaling molecule zonulin and generating lipopolysaccharides, pathogenic bacteria trigger inflammatory mediators and cause weakening of both the intestinal wall and blood–brain barrier. This leads not only to leaky gut symptoms and pathology, but an increased ability for inflammatory compounds and pathogens to enter the brain. A significantly higher percentage of pathogenic organisms, including viruses, fungi, bacteria and parasites have been found, for example, in the brains of Alzheimer's patients, compared to controls. These invaders are thought to be significant contributors to the inflammatory responses in the brain, changes in gene expression, cell atrophy and amyloid beta plaque formations that represent the pathological hallmarks of Alzheimer's.[9]

While the brain was once considered to be highly protected and independent from the rest of the body, in regards to digestion and immune function, it is now well understood that the brain is quite vulnerable to gut pathologies. As the incidence of neurodegenerative disorders such as amyotrophic lateral sclerosis (ALS), Parkinson's, Alzheimer's and other dementias skyrockets, more attention is being placed on the links between gut dysbiosis, blood–brain barrier integrity, the presence of infectious pathogens in the brain, and resulting chronic inflammation and neurodegeneration.

Conclusion

It is becoming increasingly difficult to obtain foods that are free from hormones, chemical additives, dyes, pesticides and now, glyphosate-based herbicides. These herbicides are being sprayed in increasingly large amounts on our crops, and being fed to livestock and poultry in the form of genetically modified corn- and soy-based feed. Eating a grain-free, organic diet is not simply about avoiding gluten; it is necessary in order to minimize exposure to "probably carcinogenic" chemical cocktails such as RoundUp. Choosing a Paleo diet of organic produce, free-range organic eggs and meat, and purified water is the best way to minimize internal exposure to these chemicals. Fermented foods and probiotics help to maintain proper levels of beneficial bacteria in the gut, while activated charcoal and bentonite clay can be utilized to gently cleanse the intestinal tract from unwanted toxins and chemicals. Hopefully, the growing concern for human health, animal welfare and endangered species will force policies around the use of glyphosate-based chemical cocktails to change.

Enlist Duo, the combination of glyphosate and 2,4-D (the active ingredient in Agent Orange) is now **legal in 15 states.**

The Center for Biological Diversity sued the EPA this year for **failure to protect endangered species and wildlife**, such as monarch butterflies, from agrochemicals that include glyphosate and atrazine.[10]

REFERENCES

1 Guyton KZ, Loomis D, Grosse Y, El Ghissassi F, Benbrahim-Tallaa L, et al. Carcinogenicity of tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate. *Lancet Oncol*. 2015 May 16(5):490–491. doi: 10.1016/S1470-2045(15)70134-8. Epub 2015 Mar 20.

2 Swanson NL, Leu A, Abrahamson J, Wallet B. Genetically engineered crops, glyphosate and the deterioration of health in the United States of America. *Journal of Organic Systems*. 9(2): 2014 6–37.

3 Morley W, & Seneff, S. (2014). Diminished brain resilience syndrome: A modern day neurological pathology of increased susceptibility to mild brain trauma, concussion, and downstream neurodegeneration. *Surg Neurol Int*. 2014 Jun 18;5:97. doi: 10.4103/2152-7806.134731. eCollection 2014.

4 Glyphosate. Wikipedia. https://en.wikipedia.org/wiki/Glyphosate

5 Kurenbach B, Marjoshi D, Amábile-Cuevas CF, Ferguson GC, Godsoe W, et al. Sublethal exposure to commercial formulations of the herbicides dicamba, 2,4-dichlorophenoxyacetic acid, and glyphosate cause changes in antibiotic susceptibility in Escherichia coli and Salmonella enterica serovar Typhimurium. *MBio*. 2015 Mar 24;6(2): pii: e00009-15. doi: 10.1128/mBio.00009-15.

6 Shehata AA, Schrödl W, Aldin AA, Hafez HM, Krüger M. The effect of glyphosate on potential pathogens and beneficial members of poultry microbiota in vitro. *Curr Microbiol*. 2013 Apr;66(4):350–358. doi: 10.1007/s00284-012-0277-2. Epub 2012 Dec 9.

7 Lessa FC, Gould CV, McDonald LC. Current status of Clostridium difficile infection epidemiology. *Clin Infect Dis*. 2012 Aug;55 Suppl 2:S65–70. doi: 10.1093/cid/cis319.

8 Perlmutter D. *Brain Maker*. Little Brown. 2015.

9 Hill JM, Clement C, Pogue AI, Bhattacharjee S, Zhao Y, Lukiw WJ. Pathogenic microbes, the microbiome, and Alzheimer's disease (AD). *Front Aging Neurosci*. 2014 Jun 16;6:127. doi: 10.3389/fnagi.2014.00127. eCollection 2014.

10 "Settlement: EPA to Analyze Impacts of World's Two Most Widely Used Pesticides on 1,500 Endangered Species." Center for Biological Diversity. 23 June 2015. http://www.biologicaldiversity.org/news/press_releases/2015/pesticides-06-23-2015.html