ORGANIC CONSUMERS ASSOCIATION

GLYPHOSATE FACT SHEET

Glyphosate, the key ingredient in Monsanto's Roundup herbicide, is the most widely used herbicide in the world. Its residues are found in water and soil. It's sprayed along roadsides, sidewalks, parks and playgrounds, gardens, and on school grounds. Testing shows a variety of foods contain glyphosate. It has been detected in the urine of the majority of people who have submitted samples for testing. Glyphosate has been found in breast milk, it damages the placenta and it crosses the placenta, which may result in birth defects.

Studies by independent scientists show that at the levels commonly found in the environment, on our food and in our bodies—levels that are lower than those allowed by regulatory agencies on our food—glyphosate causes a wide range of diseases and birth defects.

Cancers and Tumors

In March 2015, the World Health Organization's (WHO) International Agency for Research on Cancer (IARC) classified glyphosate as "Probably Carcinogenic to Humans" based on numerous scientific studies linking glyphosate to a range of cancers, including non-Hodgkin's lymphoma, renal cancers, skin cancers and pancreatic cancer. IARC initially published its conclusion in the *Lancet Oncology Journal*, the world's premier scientific journal for cancer studies.[1]

A study conducted by Flower et al. 2004, examined the levels of cancer in the children of people who sprayed glyphosate for weed control. They found that these children had increased levels of all childhood cancers, including all lymphomas such as non-Hodgkin's lymphoma.[2]

A case-controlled study published in March 1999, by Swedish scientists Lennart Hardell and Mikael Eriksson also linked non-Hodgkin's lymphoma (NHL) to exposure to a range of pesticides and herbicides, including glyphosate.[3]

The only published, peer-reviewed, lifetime-comparison feeding study found that rats fed a diet that contains a proportion of GM maize or minute residues of Roundup had significantly higher rates of tumors, kidney disease, liver damage and other negative health effects. Females that were fed either GM maize or non-GM maize with minute roundup residues developed large mammary tumors almost always more often, and sooner than the controls. All the non-control females, except for one that had an ovarian tumor, had mammary hypertrophies (enlarged mammary glands), and in some cases hyperplasia with atypia (nodules in the mammary glands). When compared with the control rats, treated males presented four times the number of tumors that were large enough to be felt by hand, and these occurred up to 600 days earlier.[4]

Cell Damage—Precursors to Cancer and Birth Defects

A study published in 2004, found that glyphosate-based herbicides caused cell-cycle dysregulation, which leads to cancers. According to the researchers, "Cell-cycle dysregulation is a hallmark of tumor cells and human cancers. Failure in the cell-cycle checkpoints leads to genomic instability and subsequent development of cancers from the initial affected cell." The researchers tested several glyphosate-based pesticides and found that all of them caused cell-cycle dysregulation.[5]

Research has shown that glyphosate can cause genetic damage, developmental disruption, morbidity and mortality even at what are currently considered normal levels of use.[6] The article "Differential Effects of Glyphosate and Roundup on Human Placental Cells and Aromatase," published by Richard et al. in *Environmental Health Perspectives*, revealed evidence that glyphosate damaged human placental cells within 18 hours of exposure, even at concentrations lower than those found in commercially available pesticides and herbicides. The scientists stated that "this effect increases with concentration and time, or in the presence of Roundup adjuvants."[7] (An adjuvant is any substance in a herbicide formulation or added to the spray tank to improve herbicidal activity or application characteristics).

Researchers of a study published in the journal *Toxicology* studied four different commercial glyphosate formulations and observed breaks in 50 percent of the DNA strands in human liver cells at doses as low as five parts per million (ppm). This damage affects the way DNA sends messages to several physiological systems, including the endocrine system. The researchers stated that this is significant because the liver is the first detoxification organ and is sensitive to dietary pollutants.[8]

Oxidative Stress and Cell Damage

Oxidative stress, defined as an imbalance between free radicals and the body's ability to repair the damage caused by free radicals, is one of the hallmarks of cancer, and a contributing factor to many chronic diseases. (A free radical is an atom or group of atoms that has at least one unpaired electron and is therefore unstable and highly reactive. In animal tissues, free radicals can damage cells and are believed to accelerate the progression of cancer, cardiovascular disease and age-related diseases). Oxidative stress has been linked to Alzheimer's, cancer and Parkinson's disease, among other health issues.

Cattani et al. found that both acute and chronic exposure to Roundup induced oxidative stress, resulting in neural cell death and neurotoxic effects in the hippocampus region of the brain in immature rats.[9]

Lushchak et al. found that a 96-hour exposure to low levels of Roundup in water caused oxidative stress to the cells in the brains, livers and kidneys of goldfish.[10]

Studies by El-Shenawy and de Liz Oliveira Cavalli et al. confirm that Roundup and glyphosate caused oxidative stress and necrosis in cells, including the liver, testis and Sertoli cells (responsible for testes formation and sperm production) in rats.[11]

Teratogenicity (Birth Defects) in Animals

Clements et al. published a study in 1997, showing damage to DNA in bullfrog tadpoles after exposure to glyphosate. The scientists concluded that glyphosate's "genotoxicity at relatively low concentrations" was of concern.[12]

A 2003 study by Lajmanovich et al. found that up to 55 percent of tadpoles exposed to a glyphosate herbicide had deformities to the mouth, eyes, skull, vertebrae and tails.[13]

A 2003 study by Dallegrave et al. found that the offspring of pregnant rats dosed with glyphosate had increased skeletal abnormalities.[14]

A 2004 study conducted by biologists at Trent University, Carleton University (Canada), and the University of Victoria (Canada) showed that concentrations of several glyphosate herbicides at levels found in the environment caused developmental problems in tadpoles. The exposed tadpoles did not to grow to the normal size, took longer than normal to develop, and between 10 and 25 percent had abnormal sex organs.[15]

A 2010 study found that almost 60 percent of tadpoles treated with Roundup at one ppm had malformations such as kyphosis, scoliosis and edema.[16] A 2012 study by Relyea found that tadpoles exposed to concentrations of Roundup found in the environment had changes to their tails.[17]

Paganelli et al. in 2010, found that both Roundup and glyphosate by itself caused severe malformations in the embryos of chickens and frogs and that this could occur in frogs when exposed to less than 0.5 ppm. The researchers identified the specific mechanism that glyphosate and Roundup use to cause the malformations. They found that the chemicals disrupted a key biochemical mechanism, the retinoic acid signaling pathway.[18] The retinoic acid signaling pathway is used by all vertebrates, including humans, to ensure the normal development of organs, bones and tissues in embryos. It is also essential for normal sexual development, especially in males. The pathway signals the exact time and place that the development of organs and tissues occurs in embryos. It also corrects malformations if they start. Disrupting its normal balance means that the various organs and tissues can be given signals to form incorrectly, and the pathway cannot correct any of these embryo malformations when they start forming.[19]

Research by Mesnage et al. found that Roundup from 1 ppm to 20,000 ppm causes cells of the human body to die. At 50 ppm, Roundup delays the cellular apoptosis (a process, also known as programmed cell death, whereby cells that are no longer needed or are a threat to the organism self-destruct) that is essential for the normal functioning and regeneration of cells, body tissues and organs.[20] Delaying or stopping apoptosis is considered one of the causes of cancer.

Endocrine Disruption

Gasnier et al. in 2009, reported endocrine-disrupting actions of glyphosate at 0.5 ppm. According to the authors this is "800 times lower than the level authorized in some food or feed (400 ppm, USEPA, 1998)."[21]

Professor Séralini's 2014 study published in *Environmental Sciences Europe* found that both GM maize and Roundup act as endocrine disrupters, and that consumption of GM maize and Roundup resulted in female rats dying—at rate two to three times higher than the control animals. The pituitary gland was the second-most disabled organ and the sex hormonal balance was modified in females fed with the GMO and Roundup treatments.[22].

Disruption of Metabolic Pathways

One of the most significant studies was published by Samsel and Seneff in the peer-reviewed scientific journal *Entropy* in 2013. This comprehensive review, titled "Glyphosate's Suppression of Cytochrome P450 Enzymes and Amino Acid Biosynthesis by the Gut Microbiome: Pathways to Modern Diseases," showed how glyphosate disrupted numerous biochemical pathways within the human body, including gut microorganisms, and consequently could lead to numerous diseases.[23]

Disruption of the Gut Microbiome

Samsel and Seneff's paper identified how glyphosate disrupted the gut microbiome, causing the suppression of biosynthesis of cytochrome P450 enzymes and key amino acids. In a later paper, "Glyphosate, Pathways to Modern Diseases II: Celiac Sprue and Gluten Intolerance," Samsel and Seneff showed how the current increase in celiac disease and gluten intolerance in people was linked to glyphosate's adverse effects on the gut microbiome. They highlighted that glyphosate is patented as a biocide, and consequently it kills the beneficial gut bacteria, leading to a rise in intestinal diseases.[24]

Krüger et al. showed that glyphosate has this effect in the microbiome of horses and cows.[25]

Shehata et al. found the same effects in poultry. The researchers state, "Highly pathogenic bacteria as *Salmonella* Entritidis, *Salmonella* Gallinarum, *Salmonella* Typhimurium, *Clostridium perfringens* and *Clostridium botulinum* are highly resistant to glyphosate. However, most of beneficial bacteria such as *Enterococcus faecalis*, *Enterococcus faecium*, *Bacillus badius*, *Bifidobacterium adolescentis* and *Lactobacillus* spp. were found to be moderate to highly susceptible."[26]

Both groups of researchers postulated that glyphosate is associated with the increase in botulism-mediated diseases in these domestic farm animals.

Kidney and Liver Disease

Since the 1990s, researchers in Sri Lanka have reported an epidemic of kidney failure in rice paddy workers exposed to glyphosate in combination with minerals in hard water. According to Jayasumana et al., glyphosate's strong chelating properties allow it to combine with heavy metals and arsenic in hard waters, resulting in damage to renal tissues and thereby causing chronic kidney diseases. [27]

In the lifetime feeding study of rats conducted by Séralini et al. in 2014, the treated males displayed liver congestions and necrosis at rates 2.5 to 5.5 times higher than the controls, as well as marked and severe kidney nephropathies (kidney damage) at rates generally 1.3 to 2.3 greater than the controls.

In a later published study designed to understand why Roundup and glyphosate-based herbicides caused the kidney and liver damage in rats, scientists discovered that ultra-low doses of the herbicides disrupted the functions of numerous genes, which resulted in changes consistent with multiple kidney and liver disease problems. The researchers stated, "Our results suggest that chronic exposure to a GBH (glyphosate-based herbicides) in an established laboratory animal toxicity model system at an ultra-low, environmental dose can result in liver and kidney damage with potential significant health implications for animal and human populations." [28]

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