The Glyphosate threat 2 (genetic engineering)

health issues by Heimen Julius

Abstract. Glyphosate residues in food (from spraying food crops with glyphosate) will increase when more and more genetically modified foods reach the markets. Glyphosate sinks are bone and internal organs. It is unknown what the effects will be on the human body of ingesting glyphosate over a life time. When people reach their 50s how will they stand up to the accumulated glyphosate sludge in their internal organs? And would older people have more brittle bones? And what about people with allergies?

1. Introduction

Glyphosate

Glyphosate, a herbicide produced by Monsanto since 1971, is more widely known as 'Roundup.' It is available as a weed killer for gardens from supermarkets and hardware stores. To be effective it must be sprayed onto the leaves of the plant. It should be understood that herbicides or weed killers like glyphosate are taken up by the plant and work inside plants. Insecticides or insect killers on the other hand are left on the surface of plants and can be washed off.

Glyphosate is widely used in agriculture. Many weeds are deep-rooted perennials with tubers and rootstocks. This makes them very difficult to eradicate. Through glyphosate all these problems were solved. Because, once past the leaf surface glyphosate moves throughout the plant, reaches deep into the roots and kills.

The kill-all problem

With such an all-round plant killer, you have to be very careful not to hit your crop as well. At this point a bright spark came up with the idea to make all crops glyphosate resistant. Then you could spray indiscriminately and only weeds would be killed. With the new genetic engineering techniques this idea was becoming feasible. It would result in convenient agricultural practices for farmers, who would also use much more glyphosate. And guess what, this was good for Monsanto's bottom line. So, for the last ten years genetic engineers have been making a wide variety of crops glyphosate resistant. However, little thought was given to the long term health implications of ingesting glyphosate day in and day out.

Glyphosate toxicity to humans

In 1985 a Monsanto researcher assured his readership that 'Glyphosate effectively controls 76 of the world's 78 worst weeds… and is essentially non-toxic to other life forms' (1). How reassuring if this were true. However, in 1991/92 reports appeared in the medical literature of humans being poisoned by glyphosate (2, 3). True, they attempted to commit suicide and drank a whole glass of Roundup concentrate. Still, if you would drink a whole glass of water, which **is** essentially non-toxic you would get a different result.

It turned out that if you were under 40 years of age and got timely medical assistance you would probably survive, but if you were 50 years and over you would probably die (2, 3).

The Glyphosate threat 2 (genetic engineering)

These 'results' are similar to a pharmaceutical company testing a new drug with a huge overdose. Then the evaluations start.

Single dose studies with animals

In 1985 it was reported that glyphosate fed to animals was slightly toxic. Based on animal feeding studies with a single dose it was claimed that the acute toxicity of Roundup to humans was less than table salt and half as much as aspirin (4). A rather crude and unscientific extrapolation. A publication of 1994 gives us some idea about these experiments. A single dose given to rats showed that 30 to 36% of glyphosate passed the gut wall and entered the body (6). Inside the body glyphosate was hardly broken down and showed up in urine. It's breakdown product AMPA was also found, but in minuscule amounts (5). In a follow up study, rats were fed radioactive glyphosate for 14 days. This revealed that 80 to 90% was excreted through faeces and around 10% through urine (6). Similar studies with rabbits, laying hens and lactating goats indicated that 30% of ingested glyphosate got past the gut wall (5).

Ongoing trials found that glyphosate was not fully cleared from the body. Total body clearance of a single dose was after 48 hours in male rats 94-98% and in female rats 82-84% . Another study found that it took rats around 168 hours (7 days) to eliminate glyphosate. Here, a high dose of 10 mg glyphosate per kg body weight was given. Calculations indicated that around 1% of the dose was still present in bone tissue (7). Glyphosate was also detected in egg whites and egg yolks in a study with laying hens using high glyphosate doses (5).

Glyphosate in fish

Similar research was done on fish. Glyphosate was 'not expected' to accumulate in fish, crustaceans and molluscs (10). Nonetheless, when fish and shellfish were first exposed to water containing glyphosate followed by removal of glyphosate from their water it was found that glyphosate did accumulate in their tissues (10). So much for single dose studies, but what about ongoing glyphosate intake? The difference is that in a single dose study the animal has an opportunity to clear its body, while ongoing intake makes this impossible.

Chronic vagueness and glyphosate intake

A publication from 1985 tells us that 31 mg glyphosate per kg body weight was given each day in a 26-month study with rats and that this did not result in any observable tumour formation (11). Was this the only thing they were looking for? It does not state that there was no tumour formation, only that it was not observable. And what about other toxic effects? A paper from the American Environmental Protection Agency from 1993 tells us that 'several chronic toxicity/carcinogenicity studies using rats, mice and beagle dogs resulted in no effects based on the parameters examined' (12). Again vagueness. What were these parameters? What were they looking for? The same vagueness continues throughout this paper:

A sub-chronic feeding study with rats showed effects on blood and pancreas. On mice this resulted in reduced body weights (12).

In toxicity studies with pregnant rats and rabbits, glyphosate caused treatment-related effects such as diarrhoea, reduced weight, nasal discharge and death.

The Glyphosate threat 2 (genetic engineering)

In a toxicity study (rats), kidney effects showed up in male pups, and in another study digestive effects and decreased weight (12).

In rats it appeared that very little glyphosate reached the bone marrow and that it was rapidly eliminated from bone marrow and plasma (12).

It was stressed adverse effects in these trials were only observed at the highest glyphosate doses.

Evasiveness

Why this vagueness? What are blood effects? What are pancreatic effects? What are digestive effects? What are kidney effects? And why pretend that little glyphosate reached the bone marrow? If glyphosate reaches the blood, it reaches the bone marrow. The quick elimination from marrow and plasma was probably through uptake by bone as bone is a specific glyphosate sink.

What was the duration of those chronic studies? What were the dosages given to the experimental animals and why were the feeding experiments not published on the Internet as an extension of this vague EPA paper?

Were there any updates of this EPA paper from 1993? Around 1997/8 genetically engineered foods were introduced for the first time. This paper from 1993 was the latest on feeding trials in January 2002 on the Internet.

What matters most is of course how much glyphosate will end up in our food and whether these amounts could be harmful in any way.

Acceptable glyphosate levels

Animals fed commodities from glyphosate treated fields (pre 1985) did not pass on detectable levels of glyphosate or AMPA to meat tissue, fat, eggs and milk. However, low levels were found in liver and kidney and therefore a tolerance level of 0.5 ppm was set for them (9).

The EPA (US Environmental Protection Agency) went even so far as to stipulate an acceptable dose for humans and the publication of 1985 spelled out how they arrived at this dose. They called this the acceptable daily intake or ADI, which was based on data going back to 1982.

"The acceptable daily intake (ADI) of glyphosate is 0.10 mg per kg body weight per day based on no observable effect level (NOEL) of 10 mg per kg body weight per day (rat reproduction study) and a safety factor of 100. On this basis, the maximum permitted intake (MPI) for a 60 kg man is calculated at 6.0 mg per day. With the addition of these new tolerances, the theoretical maximum residue contribution (TMRC) has been calculated at 1.39 mg per day for a 1.5 kg daily diet. All approved tolerances thus utilise about 23 percent of the ADI. These calculations suggest risks to be small relative to amounts of residue in the diet "(9).

The Glyphosate threat 2 (genetic engineering)

This calculation based on a rat reproduction study is a straight extrapolation from rats to humans. How valid is that? Anyway let us stick for the moment to 0.10 mg per kg body weight as acceptable daily intake. This calculated dose is from glyphosate on food crops when irrigation water had picked up glyphosate residues in the field. So, the glyphosate levels in question were very low anyway.

Surprise, surprise by September 1993 this acceptable daily intake had gone up to 2 mg per kg bodyweight per day. This time it was called a 'reference dose.' The EPA paper tells us about a dietary risk assessment for humans. This was based on a worst-case scenario, which meant that 100 percent of all possible commodities and acreage were treated with glyphosate and, that tolerance-level residues remained in/on all treated commodities. The EPA concluded (how??) that the chronic dietary risk to humans was minimal. And so we are informed that the EPA had determined that 2 mg glyphosate per kg body weight per day would not cause adverse effects in humans throughout a lifetime (12). This no doubt refers to those imaginary 'standard humans' who don't exist.
This whole messing round with 'acceptable' glyphosate levels misses the point totally in the presence of body sinks for glyphosate. In those places glyphosate is accumulating no matter what. An acceptable level over a life time would only make any sense in case of an ongoing complete and quick elimination of glyphosate from the body. But as the following rat study illustrates this does not happen.

Ongoing glyphosate accumulation

A table on the distribution of glyphosate in rats showed that seven days after a single dose was given, the highest glyphosate concentration was in bone. Lesser concentrations were in the colon, bone marrow, spleen, stomach, kidney and liver (8).
Table: **radioactive glyphosate per kg organ fresh weight**

Organ	**male** dose 10 mg per kg body weight	**female** same	**male** dose 1000 mg per kg body weight	**female** same
Blood	0.0045	0.0027	0.33	0.17
Liver	0.030	0.014	1.9	1.3
Kidney	0.022	0.013	1.9	1.4
Spleen	0.012	0.0073	2.6	3.0
Lung	0.015	0.012	1.5	1.1
Thyroid	0.00080	0.00036	1.5	1.2
Nasal mucosa	0.0050	0.023	1.7	1.8
Stomach	0.0080	0.0037	2.4	2.4
Small intestines	0.022	0.018	1.9	1.6
Colon	0.034	0.016	11.0	9.2
Bone	**0.55**	**0.31**	**30.6**	**19.7**
Bone marrow	0.029	0.0064	4.1	12.5

The Glyphosate threat 2 (genetic engineering)

The full description of the table was as follows: Concentrations of ^{14}C label (as mg glyphosate-equivalents/kg fresh weight) in selected tissues of rats on day 7 after a single oral dose (rounded values) (Monsanto, 1988b).

This table is from a 1994 WHO publication (8) and tells us that 'the isotope was widely distributed throughout the body, but was primarily found in bone'. As the table shows it concerns here two different doses: 10 and 1000 mg glyphosate per kg bodyweight.

Another study is mentioned in this WHO paper whereby radioactive glyphosate was determined again in rat tissues. This occurred on several occasions throughout a treatment period of 14 days and a post-dosing withdrawal period of 10 days (dietary administration of radioactive glyphosate at 1, 10 and 100 mg/kg diet). Maximum tissue levels were reached after 10 days or less, with highest concentrations in kidneys. (Monsanto, 1973c). In this study no concentrations in bone or bone marrow were measured (8).

These studies show that a proposed reference dose misses the point totally. **Once you find evidence of specific sinks for glyphosate in the mammalian body, a reference dose makes no longer any sense as it is based on the assumption of ongoing total clearing of glyphosate from the body.** So, the question becomes how will glyphosate accumulate in people's bodies over a lifetime and how will this affect their health? Let us have a closer look at some accumulation points and make an estimate of the possible consequences.

Effects of glyphosate in body

Bone: this is a living tissue that is constantly broken down and reassembled, especially during growth and healing of broken bones. Its major constituent is calcium phosphate. In the plant world glyphosate acts as a fake phosphate. It may well act in a similar way in bone tissue and interfere in normal bone formation. Could any build-up in glyphosate cause weaker bones? Could it contribute to bone deformities? Could it slow down the healing of broken bones? And could it cause more brittle bones in old age? No one really knows.

Bone marrow: here blood bodies are produced. How glyphosate influence these processes is anyone's guess. Could it lead to lower output of red blood bodies? In other words could it contribute to anaemia? And what about the many kinds of white blood bodies? Could glyphosate moving continuously through bone marrow on its way to being fixed in bone tissue lead to an impaired immune system? Or worse even, could it contribute to leukaemia ? No one really knows.

Spleen: this is another point where the immune system could be weakened by glyphosate build-up.

Stomach: if lining the stomach wall with glyphosate would hamper stomach acid production, then this could spell troubles for digestive processes. Or, could glyphosate contribute to stomach ulcers through increased acid production? No one really knows.

Liver: here many functions are performed. One of them is detoxification. Given the glyphosate sinks in the body, this detoxification process is not very effective for glyphosate. A build-up of glyphosate would very likely impair liver functioning. Could glyphosate contribute to liver cancer? No one really knows.

The Glyphosate threat 2 (genetic engineering)

Pancreas: here are digestive enzymes secreted. If membranes become plastered with glyphosate, would this hamper the amount of enzyme secreted? Could this result in digestive problems? Also, the pancreas is where insulin is produced. Could insulin production be hampered by glyphosate build-up and contribute to diabetes? No one really knows.

Colon: this is the place where water is resorbed from the gut. It prevents water loss from the body. Often toxins are moved back into the body if the contents remains too long inside the colon. So, regular elimination is important (a shit a day, keeps the doctor away). If glyphosate starts to build up in the colon wall, could this hamper the water resorption? Could this mean in later life chronic diarrhoea and too much water loss? Could glyphosate build-up contribute to colon cancer? No one really knows.

Kidneys: they filter blood and through resorption urine is separated from the blood. The kidneys are structured as a bundle of very fine tubes. Within these tubes filtration and resorption take place at different locations. It seems obvious that any glyphosate coating of those tubes will hamper the filtration and resorption processes. In other words it will lead to an impairment of the kidneys. How will ongoing impairment of the kidneys work out over a life time? No one really knows.

The peculiar role of the WHO

So far the World Health Organisation has not made any waves about genetically engineered foods. Their attitude is rather peculiar. They also produce lists with glyphosate tolerances, which tend to be copies of the EPA tables. So, the EPA is in general calling the shots.

A WHO report on glyphosate was published by them in 1994 as Environmental Health Criteria 159 (5). It mentions another report claiming that glyphosate was found in groundwater in Texas, USA. No details were given about the measured concentration or the year of measurement (13). This same WHO report informs us that when glyphosate was applied 5 to 14 days before the harvest of cereals that this resulted in significant residue uptake in the grain and plant materials. What happened then to these residues during milling, baking and brewing is also revealed.

Residues in white flour were approximately 10-20% of those of wheat. Bran had 2 to 4 times more glyphosate than wheat. During baking no glyphosate was lost, but during bread making glyphosate levels were diluted (14).

Glyphosate in malt and beer originated from barley that was treated in the field. Levels in malt and beer were around 25 and 4% of that in barley. Some of the glyphosate was lost by washing, but most decrease was from dilution in the brewery processes (14).

Glyphosate in groats (processed oats) was around 50% of that in oats from fields with pre-harvest spraying of glyphosate (14).

Despite these findings no direct measurements of glyphosate in foods (as part of food surveillance), in drinking water or in total diets had been carried out by 1994 (13, 14). The odd thing here is that the WHO did not recommend that this should be done. They only establish this fact and then move on. Their only report so far on glyphosate seems to be the

The Glyphosate threat 2 (genetic engineering)

one of 1994: Glyphosate - Environmental Health Criteria 159 and is more about environmental issues than about human health.

It was put together by 'an international task group of experts.' One expert from an Institute of Terrestrial Ecology, one from a College of Agriculture, two from a National Institute of Public Health and Environmental Hygiene, one from a National Environmental Protection Agency and … one from the US Environmental Protection Agency, their Health Effects Division.

Human health effects are hardly touched upon in this report. Most health effects concern animals in trials with a single dose or tests of some longer duration. Any adverse effects that show up are just mentioned without going into any depth about the human health implications.

A cursory look through the reference section shows 360 references, but only 159 are from scientific journals and 201 from never published research. Oddly enough, the monograph on glyphosate from 1985 put together by genuine experts in their field (4) was not included.

Unpublished research

It turns out that this unpublished research was done by the following big companies.

Monsanto, - Rhone Poulenc (French), - Luxan BV (Dutch), - Agrichem BV (Dutch), - Institute for Technical Scientific Services GmbH (German), - Cheminova A/S (Danish), - Institute for Environmental Analysis and Biotechnology (German), - International Bioresearch Hannover (Germany), - Huntingdon Research Centre (UK), - Food & Drug Research Laboratories Waverly, New York (USA), - EVS Consultants Seattle, Washington (USA), - Analytical Biochemistry Laboratories Inc. Columbia, Missouri (USA), - Aquatic Toxicology Laboratory Wareham, Massachusetts (USA), - Marine Research Laboratory Pensacola, Florida (USA), - Bio/Dynamics Inc. Dept of Toxicology East Millstone, New Jersey (USA).

Some questions

It doesn't seem that the mentioned companies have much to do with human health issues. Some questions come immediately to mind: why was their research not published in scientific journals and opened up for peer review? Who commissioned this research? The WHO would not have had the money. Was it Monsanto? Who determined the research procedures? Was this left to the scientists of these companies or were they under contract to do the research in a certain way? In other words, was it genuine research or could it have been set up with certain outcomes in mind?

It would not be the first time that this happened. Then fake research is used to crowd out genuine research leading to outcomes favouring commercial interests. It is not said that this occurred here, only that it could have happened. The best way to dispel any such suspicion is by publishing this research and open it up to peer review with a short explanation as to why this had not been done earlier.

The Glyphosate threat 2 (genetic engineering)

The WHO should have the common sense to stay clear of unpublished research; why at all endorse unpublished research? And … why was this WHO expert task force extended with an observer from Monsanto? Was this an attempt to influence the direction this publication would take?

It is obvious that a WHO publication with so much unpublished research cannot be given much scientific credence. The secrecy of the mentioned research enables the companies involved to tell us anything they like.

What next WHO?

We have now the situation whereby the WHO is occupied with environmental issues and the US Environmental Protection Agency is making statements about human health. This looks like the world upside down.

The contributor from the US Environmental Protection Agency to this WHO publication was Dr M.S. Morrow, Health Effects Division, Office of Pesticide Programs, US Environmental Protection Agency. So, here we have them all: the EPA has an Office of Pesticide Programs and this has a Health Effects Division. This arrangement would seem that pesticide programs are more important than human health issues. Is there any evidence for this? The setting of glyphosate tolerance levels for food seems to point in that direction.

Maximum residue tolerances

In 1982 the EPA set maximum glyphosate levels for a number of food items. To quote: "Maximum residue tolerances in most foods for direct consumption, whether meat, fruit or vegetable, are around 0.2 parts per million (ppm), although those in grain products, normally eaten in larger quantities, are lower (0.1ppm). Actual residues in these commodities are usually found to be much lower. Residue studies in animals have shown no detectable levels (<0.05 ppm) of glyphosate or its metabolite to be present in meat tissue, fat, eggs or milk. Low levels were found in liver and kidney and, therefore, a tolerance of 0.5 ppm has been set" (9). This quote is accompanied by a list of 50 food items. And sure enough most items are in the 0.1 and 0.2 ppm range. But a few stick out.

Some tolerance levels

In the following table I have combined some of the values I found in the individual tables for 1982, 1997 and 2001. The bold figures show a trend over the years.

The Glyphosate threat 2 **(genetic engineering)**

§ 180.364 Glyphosate; tolerances for residues in parts per million (ppm)

item	**1982**	**1997**	**2001**
grain crops	**0.1**	0.1 except wheat, oat, sorghum, barley	
barley grain	**0.1**	**20**	**20**
barley bran		30	30
wheat grain	**0.1**	**5**	**5**
wheat milling fractions (excluding flour)		20	20
wheat straw		85	not mentioned
wheatgrass		200	,, ,,
oat grain	**0.1**	**20**	**20**
sorghum grain	**0.1**	**15**	**15**
grapes	0.2	0.2	0.2
Citrus, fruits	0.2	0.5	0.5
Pome fruits	0.2	0.2	0.2
Stone fruit	0.2	0.2	0.2
Leafy vegetables	0.2	0.2	0.2
Soya beans	**6**	**20**	**20**
soyabean forage	15	100	100
soyabean hay	15	200	200
cattle, kidney	**0.5**	**4**	**4**
cattle, liver	0.5	0.5	0.5
Fish	0.25	0.25	0.25

Forage and hay with high glyphosate levels fed to animals cause of course high glyphosate levels in their livers and kidneys.

The slightly higher accepted level in fish from 1982 onwards indicates that fish is a glyphosate sink.

A new table appeared in 1997 (15). This time there were 133 items and after having entered the era of glyphosate resistant crops some tolerance levels went up remarkably.

Remember what in 1982 was stated? Here it is again: "Maximum residue tolerances in most foods for direct consumption, whether meat, fruit or vegetable, are around 0.2 ppm, **although those in grain products, normally eaten in larger quantities, are lower (0.1ppm)**." But in 1997 the wheat tolerance level was raised to 5 ppm. On what grounds? Obviously to remain in step with the new glyphosate practices for glyphosate resistant crops. This tolerated ppm increase shows clearly that human health is less important to the EPA than pesticide use.

Other grain crops (except wheat, oats, grain sorghum and barley) remained at 0.1 ppm.

The Glyphosate threat 2 (genetic engineering)

A new update from September 2001

The list contains this time 178 items and we are informed that approved pesticides and tolerances are constantly changing (16).

A trend

A trend is emerging: first reassuring statements are made based on research results with **glyphosate sensitive** crops. The 1993 paper on the Internet with a worst case scenario is based on research with glyphosate sensitive crops and glyphosate levels representing irrigation water that might have picked up glyphosate in the field.

Then the glyphosate tolerance levels are raised to bring them into line with the new practices for **glyphosate resistant** crops. And … hopefully nobody will notice the deceit.

Another trend is that the list of glyphosate tolerances for plants gets longer and longer. This indicates that more and more plants are being considered for genetic engineering.

No evaluations have been made so far by the WHO it seems concerning people with allergies. Why not? (Because no allergic rats were ever tested!)

Conclusions

1. Acceptable levels of glyphosate intake for humans is determined by the US Environmental Protection Organisation, largely based on rat studies. Adverse affects that showed up were ignored and reported in the vaguest possible way. The fact that glyphosate sinks were found in rats, other mammals and fish makes this approach meaningless.

2. The signs are on the wall that glyphosate will build up in bone and internal organs over a life time. Nobody knows how our bodies will stand up to increasing glyphosate sludge in our internal organs. And what will be the effects on ageing bones? What will be people's health prospects be at age 45-50 after a life time of ingesting glyphosate? And what about people with allergies?

3. All foods will in due time contain substantial amounts of glyphosate and/or other herbicides for which food crops have been made genetically resistant.

4. With continuously upwards changing glyphosate tolerance levels, the final body load of glyphosate from daily food intake will be anybody's guess. It will increase progressively over time.

5. The World Health Organisation should pull up its socks and focus on human health issues. It should stop endorsing unpublished research and so making itself a respectability shield for big business.

6. The dosing of food crops with herbicides is from a public health viewpoint unacceptable and should be prohibited by law.

The Glyphosate threat 2 (genetic engineering)

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5. Mensink H. et al.1994. Glyphosate. Environmental Health Criteria 159, by World Health Organisation, Geneva. p. 66

6. Ibid 5 at pp. 63-64

7. Ibid 5 at p. 67.

8. Ibid 5 at pp. 64-65

9. Ibid 4 at p. 132.

10. Ibid 5 at pp. 52-54.

11. Ibid 4 at p. 130.

12. http://www.epa.gov/pesticides/search.htm in browsing you come somewhere across EPA R.E.D. FACTS this is the paper. You find in the heading EPA-738-F-93-011 September 1993. Go to section: Human Health Assessment.

13. Ibid 5 at p. 55.

14. Ibid 5 at 59.

15. This list appeared in a publication of 1999 by the Environmental Protection Agency and to my eternal shame I did not jot down its complete title. It concerns a large collection of pesticide residue tolerances in ppm and under § 180.364 you find a list of 133 items for glyphosate residues. The list itself is from 1997 and is also on a federal register (FR 17730, Apr.11, 1977). Fortunately an update of this list is now on the Internet.

16. www etc as ref.12. From there go to OPP Home if you are not there already. This is the Office of Pesticide Programs home page. Under 1 Enter words/phrases in text box, fill in as follows: **glyphosate and tolerances and crop and § 180.364.** Under 2 Limit your research fill in text box: **all of these words** and within **the entire document.** Then click on the link to your database. This is on right side of your page under Database Searches.**Click on** Pesticide Residue Limits on Food. Now you should get the table on glyphosate tolerances.