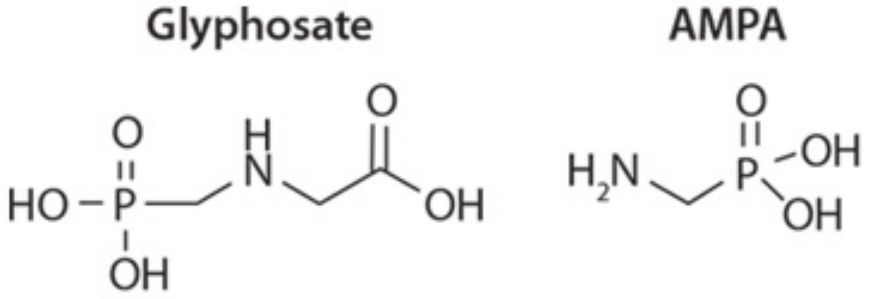


Glyphosate

VERMONT
AGENCY OF AGRICULTURE, FOOD & MARKETS

What is glyphosate?

- Non-Selective Herbicide:
  - Grasses
  - Broadleaf plants
- First registered in the US in 1974
- Most widely used pesticide in the world
- Over 750 products containing glyphosate in the US

How is it used in Vermont?

- Glyphosate containing products, such as Roundup, are used to control a wide variety of weeds in many different settings, including:
  - Agriculture: terminating cover crops, weed control conventional crop cultivation and in genetically engineered (GE) corn and soybean crops
  - Weed control in ornamental plantings, lawns, and turf
  - Right-of-Way maintenance
  - Invasive plant control
- One of the most used herbicides in the state

How does it work?

- Glyphosate prevents plants from making certain proteins that are needed for plant growth
- Stops a specific enzyme pathway (shikimic acid pathway)
- The shikimic acid pathway is only found in plants, fungi, algae, bacteria, and some other micro-organisms.
- Glyphosate must be applied to actively growing plants in order to work.

Glyphosate in the environment

- Glyphosate binds tightly to soil. It can persist in soil for up to 6 months depending on the climate and soil type.
- Glyphosate is broken down by bacteria in the soil.
- Unlikely to get into groundwater because glyphosate binds tightly to soil.
- Pure glyphosate is low in toxicity to fish and wildlife, but some products containing glyphosate may be toxic because of the other ingredients in them.

How is glyphosate evaluated for safety?

- The Environmental Protection Agency (EPA), evaluates and registers pesticides for use.
- Scientific process to evaluate risks: human health and environment
- Toxicity test –how poisonous a chemical is: Acute and Chronic

Measures of Toxicity: The Median Lethal Dose

LD_{50}

The amount (dose) of a chemical which produces death in 50% of a population of test animals to which it is administered by any of a variety of methods

mg/kg (ppm)

Normally expressed as milligrams of substance per kilogram of animal body weight

Remember:

- For pesticides – less is more when dealing with toxicity
- The less you need to cause a toxic effect – the more toxic the substance is
- Thus an LD_{50} of 25 mg/kg is more toxic than is one of 7,000 mg/kg

Is glyphosate safe?

- No pesticide is **SAFE**
- Glyphosate can be used safely by following the label
- Glyphosate is low risk
- Relatively non-toxic to humans

Acute Toxicity: Life-threatening one-time dose

Substance	Found In	Lethal Dose (LD50)	Toxicity
Water	Water	90,000	Practically non-toxic (>5,000 mg/kg)
Sucrose	Table sugar	29,700	
Ethanol	Beer, wine, spirits	7,060	
Calcium carbonate	Antacids	6,450	
Glyphosate	Herbicide (Roundup®)	4,900	Slightly (500 - 5,000 mg/kg)
Sodium chloride	Table salt	3,000	
Acetaminophen	Tylenol	1,944	
2,4-D	Herbicide	666	
Codeine	Pain killer, cough suppressant	427	Moderately (50 - 500 mg/kg)
Copper sulfate	Organic fungicide	300	
Caffeine	Coffee, tea, soda	192	
Rotenone	Botanical insecticide	60	
Vitamin D3	Supplements	42	Highly (1 - 50 mg/kg)
Nicotine	Cigarettes	9	
Hydrogen cyanide	Fruit pits	4	
Botulinum toxin	Botox	<0.001	

Glyphosate in food:

- Glyphosate is used on a wide variety of crops
- Trace amounts have been found in many products

Here's what we know about glyphosate residues in our food:

§180.364 Glyphosate; tolerances for residues.

(a) *General.* (1) Tolerances are established for residues of glyphosate, including its metabolites and degradates, in or on the commodities listed below resulting from the application of glyphosate, the isopropylamine salt of glyphosate, the ethanolamine salt of glyphosate, the dimethylamine salt of glyphosate, the ammonium salt of glyphosate, and the potassium salt of glyphosate. Compliance with the following tolerance levels is to be determined by measuring only glyphosate (*N*-(phosphonomethyl)glycine).

Commodity	Parts per million
Acerola	0.2
Alfalfa, seed	0.5
Almond, hulls	25
Aloe vera	0.5
Ambarella	0.2
Animal feed, nongrass, group 18	400
Artichoke, globe	0.2
Asparagus	0.5
Atemoya	0.2
Avocado	0.2
Bamboo, shoots	0.2
Banana	0.2
Barley, bran	30
Beet, sugar, dried pulp	25
Beet, sugar, roots	10
Beet, sugar, tops	10
Berry and small fruit, group 13-07	0.20
Betelnut	1.0
Biriba	0.2
Blimbe	0.2
Breadfruit	0.2
Cacao bean, bean	0.2
Cactus, fruit	0.5
Cactus, pads	0.5
Canistel	0.2
Carrot	5.0
Chaya	1.0
Cherimoya	0.2
Citrus, dried pulp	1.5
Coconut	0.1
Coffee, bean, green	1.0
Corn, pop, grain	0.1
Corn, sweet, kernel plus cob with husk removed	3.5

EPA acceptable limits:

Daily Food: RfD = 1.00 mg/kg/day

Therefore:

1 kilogram = 2.2 pounds

A 65 kg (143 lbs) person could allowably consume 65 mg glyphosate per day and expect no long/short term effects including cancer risks.

EPA acceptable limits:

Daily Food: RfD = 1.00 mg/kg/day

1.0 mg of glyphosate

for each kilogram of your body weight

per day

Exposure to Glyphosate:

What happens to glyphosate when it enters the body?

- In humans, glyphosate does not easily pass through the skin. Glyphosate that is absorbed or ingested will pass through the body relatively quickly. The vast majority of glyphosate leaves the body in urine and feces without being changed into another chemical.

Are children more sensitive to glyphosate than adults?

- As required by the Food Quality Protection Act, the EPA has determined that children are not more sensitive to glyphosate as compared to the general population.

So why then is glyphosate considered to cause cancer?

2015 International Agency for Cancer Research (IARC) placed glyphosate into their Group 2A category.

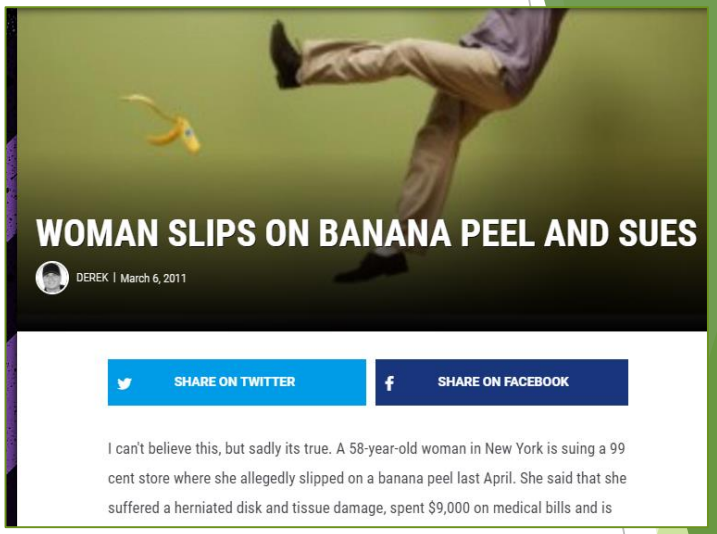
- Doesn't look at risk
- Excluded much of existing reputable evidence

US EPA, EU, Japan, Australia, New Zealand, Canada, WHO, and many other governments do not classify glyphosate as carcinogenic to humans.

Hazard vs Risk

Hazard vs Risk

- Banana and vehicle:
  - Both can cause accidents
  - Both pose a hazard

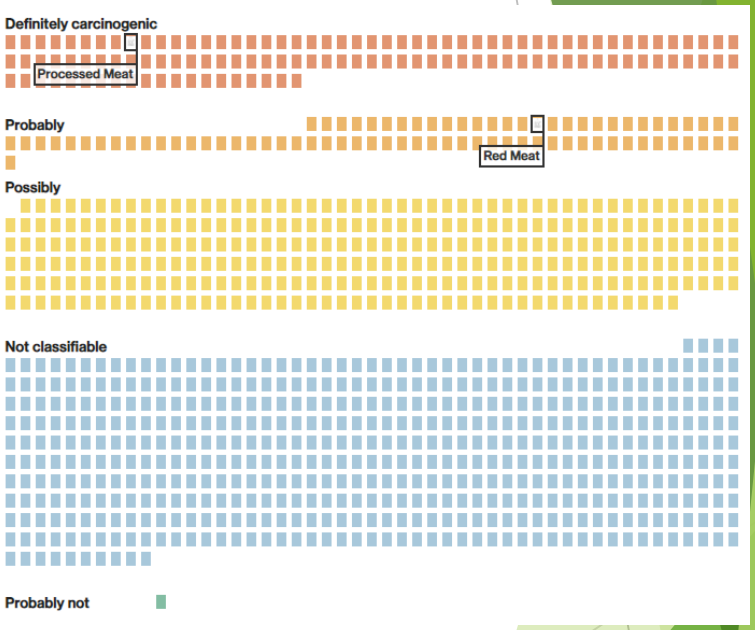


http://999thepoint.com/woman-slips-on-banana-peel-and-sues/

- The automobile is riskier because you are much more likely to be in an automobile crash than a banana accident.
- Banana accidents pose less risk.

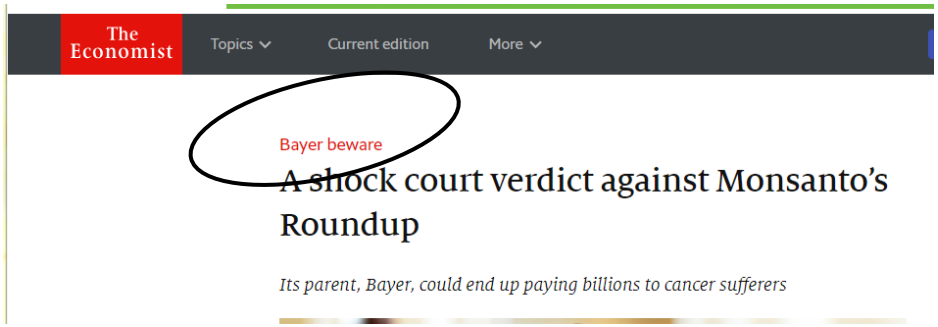
Sum of IARC's cancer determinations grouped by category

https://www.compoundchem.com/2015/10/26/carcinogens/



https://www.bloomberg.com/graphics/2015-red-meat-cancer/

And now, … for cancer?



- $289 million awarded to school groundskeeper
- Terminally ill with non-Hodgkin lymphoma
- Was "doused" several times, plus sprayed in the face regularly
- Cancer developed 18-24 months after starting position using glyphosate
- Ruling did not change the science
    - Agricultural Health Study does not support a cause and effect relationship between exposure and non-Hodgkin lymphoma

EPA - Glyphosate

- Interim Decision: February 3, 2020
  - https://www.epa.gov/ingredients-used-pesticide-products/proposed-interim-registration-review-decision-and-responses-0
  - Cancer Classification: “Not likely to be a carcinogen to humans”
  - Use according to label prevent adverse effects to the ecosystem
- New proposed label (label = law) changes :
  - Spray Drift Management – reduce off-target
  - Herbicide Resistance Management
  - Non-target Organism Advisory Statement
  - Label Consistency Measures

References:

- 1 Charles M Benbrook. Impacts of genetically engineered crops on pesticide use in the U.S. -- the first sixteen years. Environmental Sciences Europe, 2012; 24 (1): 24 DOI: 10.1186/2190-4715-24-24
- 2 S. Parvez, R. R. Gerona, C. Proctor, M. Friesen, J. L. Ashby, J. L. Reiter, Z. Lui and P. D. Winchester. Glyphosate exposure in pregnancy and shortened gestational length: a prospective Indiana birth cohort study. Environmental Health 2018 17:23 DOI: 10.1186/s12940-018-0367-0
- 3 U.S. Department of the Interior | U.S. Geological Survey URL: http://water.usgs.gov/nawqa/
- pnsp/usage/maps/show_map.php?year=2015&map=GLYPHOSATE&hilo=L&disp=Glyphosate Page Contact Information: gs-w_nawqa_whq@usgs.gov Page Last Modified: September 11 2017 13:41:21.
- 4 https://www.ams.usda.gov/datasets/pdp
- 5 https://www.fda.gov/downloads/Food/FoodborneIllnessContaminants/ Pesticides/UCM582721.pdf
- 6 Pupke D, Daniel L, Proefrock D (2016) Optimization of an Enrichment and LC-MS/MS Method for the Analysis of Glyphosate and Aminomethylphosphonic Acid (AMPA) in Saline Natural Water Samples without Derivatization. J Chromatogr Sep Tech 7: 338. doi: 10.4172/2157-7064.1000338
- 7Glyphosate detection: methods, needs and challenges" in Environmental Chemistry Letters (Valle, A.L., Mello, F.C.C., Alves-Balvedi, R.P. et al. Environ Chem Lett (2018). https://doi.org/10.1007/s10311-018-0789-5
- 8 https://www.glsciences.com/pdf/technicalnote_lc/013.pdf
- 9 https://www.ecfr.gov/cgi-bin/retrieveECFR?gp=1&SID= 6e1d31849bf38fcb8ca5a68752ec62c3&ty=HTML&h=L&mc=true&r=SECTION&n=se40.26.180_1364
- 10Gold, Ames, and Slone. 2002. Misconceptions About the Causes of Cancer, Human and Environmental Risk Assessment: Theory and Practice, p 1415-1460.
- 11Ames and Gold. 1998. The causes and prevention of cancer: the role of environment. Biotherapy. 11(2-3), 205-220.
- 12 Anand et al. 2008. Cancer is a Preventable Disease that Requires Major Lifestyle Changes. Pharm Res. 25(9) 2097-2116.