



# | Glyphosate pesticide in beer and wine

Test results and future solutions

# **Glyphosate Pesticide in Beer and Wine**



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U.S. PIRG Education Fund  
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The authors bear responsibility for any factual errors. Policy recommendations are those of U.S. PIRG Education Fund. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

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## Executive Summary

Roundup is everywhere. As the most commonly used agrichemical in the world, Roundup and its main active ingredient, glyphosate, is showing up in places people do not expect, such as food and drinks.<sup>1</sup> In this report, we tested beer and wine and found glyphosate in beer and wine from the U.S., Europe, and Asia. We even found glyphosate in some unexpected places, such as in some organic varieties.

While glyphosate is found in many places, for many years scientists were uncertain if glyphosate was a public health problem.<sup>2</sup> But that changed in 2015, when the World Health Organization (WHO) found that glyphosate is a probable carcinogen.<sup>3</sup> In 2017, the state of California also decided to list glyphosate as a probable carcinogen based on the WHO study.<sup>4</sup>

This news has far-reaching impacts. In 2018, a jury in California found that Monsanto's failure to warn a man of the dangers of using Roundup was a probable cause of his cancer, and awarded him \$289 million in damages.<sup>5</sup> Thousands of other people, mostly farmers, are now alleging that their incurable cancers may have been caused by Roundup.<sup>6</sup> And in January 2019, France banned the use of Roundup 360, citing it as a "serious risk" to human health.<sup>7</sup> Other countries in the EU are considering other glyphosate bans.<sup>8</sup>

Despite these risks, the use of Roundup is growing at such a rapid pace that there is enough glyphosate sprayed every year to spray .8 pounds of glyphosate on every cultivated acre of land in the U.S., and spray nearly half a pound of glyphosate on every cultivated acre of land in the world.<sup>9</sup>

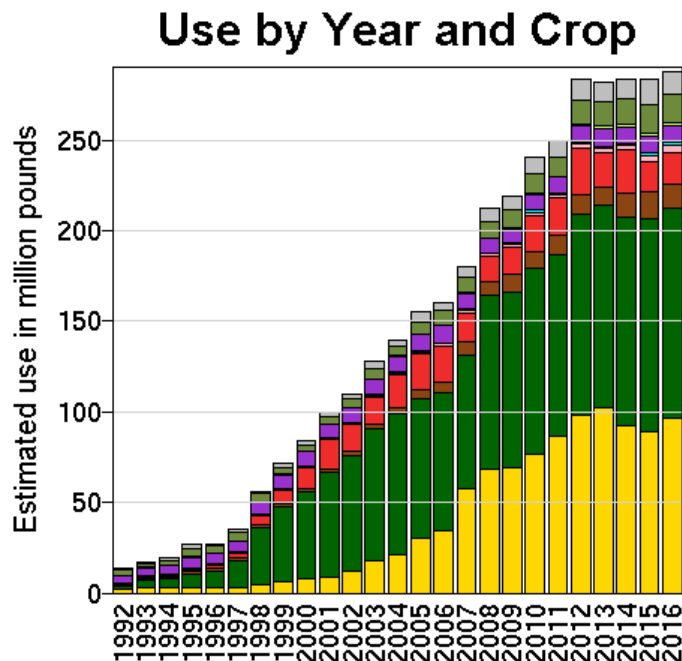


Figure 1: Use of Glyphosate in Crops, credit [U.S. Geological Survey](#)

To explore how much Roundup we're drinking, U.S. PIRG tested beer and wine for glyphosate/Roundup. As we've confirmed in this study, Roundup is found in beer and wine. This aligns with past studies on the topic, which found that glyphosate is found in almost all adult beverages. For example, in 2016, beer testing in Germany also revealed residues of glyphosate in every single sample tested, even in independent beers.<sup>10</sup> After that study was released, German brewers managed to severely limit the amount of glyphosate used in crops for brewing, and saw marked improvement in a 2017 follow-up study.<sup>11,12</sup> A study from 2018 in Latvia came to similar conclusions as the original German study, finding glyphosate in all products tested.<sup>13</sup>

We tested 20 products: 5 wines and 15 beers. The wine brands tested included Beringer, Barefoot and Sutter Home. Beer brands tested included Budweiser, Coors, Miller Lite, Sam Adams, Samuel Smith Organic, and New Belgium.

Notable findings:

- Of the 20 samples, 19 contained glyphosate. The highest level of glyphosate found was in Sutter Home wine, at 51 parts per billion (ppb).
- Our results also showed that 3 of 4 organic beer and wine contains glyphosate. Although glyphosate is not allowed or used in organic farming, several types of organic products were contaminated, such as Samuel Smith Organic (at 3.5 ppb). Inkarri Estate organic wine contained 5.2 ppb.
- Large, conventional brands such as Coors, Tsingtao, and Miller Lite showed glyphosate levels above 25 ppb.
- One brand, Peak Beer, did not contain detectable levels of glyphosate.

While these levels of glyphosate are below EPA risk tolerances for beverages, it is possible that even low levels of glyphosate can be problematic. For example, in one study, scientists found that 1 part per trillion of glyphosate has the potential to stimulate the growth of breast cancer cells and disrupt the endocrine system.<sup>14</sup>

Our findings suggest that it is very difficult to produce beer or wine without glyphosate contamination, even for organic producers. The Brewers Association, which certifies small independent and craft beers, opposes glyphosate use in their beer according to information they have given to U.S.PIRG:

“Brewers do not want glyphosate used on barley or any raw brewing material, and the barley grower organizations have also come out strongly against glyphosate.”<sup>15</sup>

Our findings suggest that glyphosate contamination is common in beers and wine sold in the U.S. Due to glyphosate's many health risks and its ubiquitous nature in our food, water, and alcohol, the use of glyphosate in the U.S. should be banned unless and until it can be proven safe.

## **Introduction**

Roundup, the most famous formulation of the weed-killer glyphosate, has been a hot topic lately. In the past year alone, thousands of people have accused Roundup's manufacturer, Monsanto, of being a major contributor of their cancer.<sup>16</sup> Several countries in the E.U. have considered banning it, and one—France—did ban one version of it in January 2019.

Roundup and Monsanto additionally came under fire when court documents revealed that Monsanto had been influencing allegedly-independent scientists who were researching the safety of Roundup.<sup>17</sup> Following this news in 2017, several attorneys general and Congressmen called for an investigation into Monsanto's influence on scientific studies.<sup>18</sup>

Most people think of Roundup as a weed-killer that they use in their homes and gardens. However, Roundup is actually more commonly used commercially for agriculture. Roundup is the most commonly-used herbicide in the world and its main ingredient, glyphosate, is sprayed on many different crops that people will eat or drink.

Despite how much Roundup is used, no government agency in the U.S. conducts regular safety testing for glyphosate on either food or beverages.<sup>19</sup> When the U.S. Food & Drug Administration (FDA) did some spot-checking for glyphosate in 2017, the only product they could find that did not contain glyphosate was broccoli.<sup>20</sup> They found glyphosate in items like granola cereal.<sup>21</sup>

Other recent testing has found glyphosate on children's cereal and Ben & Jerry's ice cream (following which, Ben & Jerry's vowed to remove glyphosate-containing ingredients from future ice cream).<sup>22,23</sup>

Based on how much glyphosate is being discovered in so many products, we tested several types of beer and wine to see if consumers are being exposed to glyphosate in beverages.

## **Background:**

### **Health Risks of Using Glyphosate**

For many years, glyphosate was billed as a healthy alternative to more dangerous pesticides.<sup>24</sup> But in the past few years, scientists are increasingly finding that glyphosate poses probable health risks. This new research, including some done by the World Health Organization (WHO), found that Roundup, and other glyphosate-based herbicides, could pose significant risks to human health.<sup>25</sup>

In one study by the WHO's cancer arm, the International Agency for Research on Cancer (IARC), scientists linked glyphosate – the main chemical ingredient in Roundup – to cancer.<sup>26</sup> While another report by the World Health Organization said the actual risk given probable exposure to glyphosate was unlikely to be harmful.<sup>27</sup>

But Roundup, is not *just* glyphosate. It is a cocktail of different chemicals, and there is mounting evidence that this cocktail could be a dangerous one. Two studies determined that herbicides like Roundup, were more likely to cause cell-cycle dysregulation, a hallmark of cancer, than glyphosate alone.<sup>28,29</sup> And a 2009 study showed that some formulations of Roundup were more toxic to human umbilical, embryonic, and placental cells than glyphosate by itself.<sup>30</sup>

There is clearly enough evidence to indicate that we shouldn't be needlessly exposing ourselves to something that has the potential to cause such serious harm. But that is exactly what we are doing, and in a big way.

### **Recent Policy Changes and Litigation Due to Health Risks of Glyphosate**

In 2017, in response to additional scientific information and the World Health Organization's listing of glyphosate as a probable carcinogen, California listed glyphosate in its Proposition 65 registry of chemicals known to cause cancer.<sup>31</sup> Communities such as Irvine, California, decided to ban the use of Roundup and other glyphosate-based pesticides on city property.<sup>32</sup>

Meanwhile, a California jury ordered Monsanto, the maker of Roundup, to pay \$289 million in damages to a man dying of cancer, which he says was caused by his repeated exposure to large quantities of Roundup and other glyphosate-based weed killers while working as a school groundskeeper.<sup>33</sup> Thousands of other plaintiffs with cancer have sued Monsanto in state and federal courts.<sup>34</sup>

This year, France took an important step to protect public health by banning a form of the pesticide Roundup.<sup>35</sup> This ban comes after a French court ruled that regulators did not adequately consider public health when originally evaluating the safety of Roundup Pro 360.<sup>36</sup> The French court noted that recent health studies have indicated that there is a significant risk to using Roundup, and that the French regulators have to consider those risks before allowing the use of the new Roundup formula, Roundup Pro 360.<sup>37</sup>

Many other countries are considering Roundup bans.<sup>38</sup> In addition, many other communities in the U.S. are considering a Roundup/glyphosate ban.

At this time, the U.S. EPA is not considering banning Roundup.

### **How Glyphosate Contaminates Beer and Wine in Agriculture**

Despite these health risks, Roundup and other glyphosate-based weed-killers are commonly used in agriculture in the U.S., and this is how glyphosate ends up in so many beers and wines.

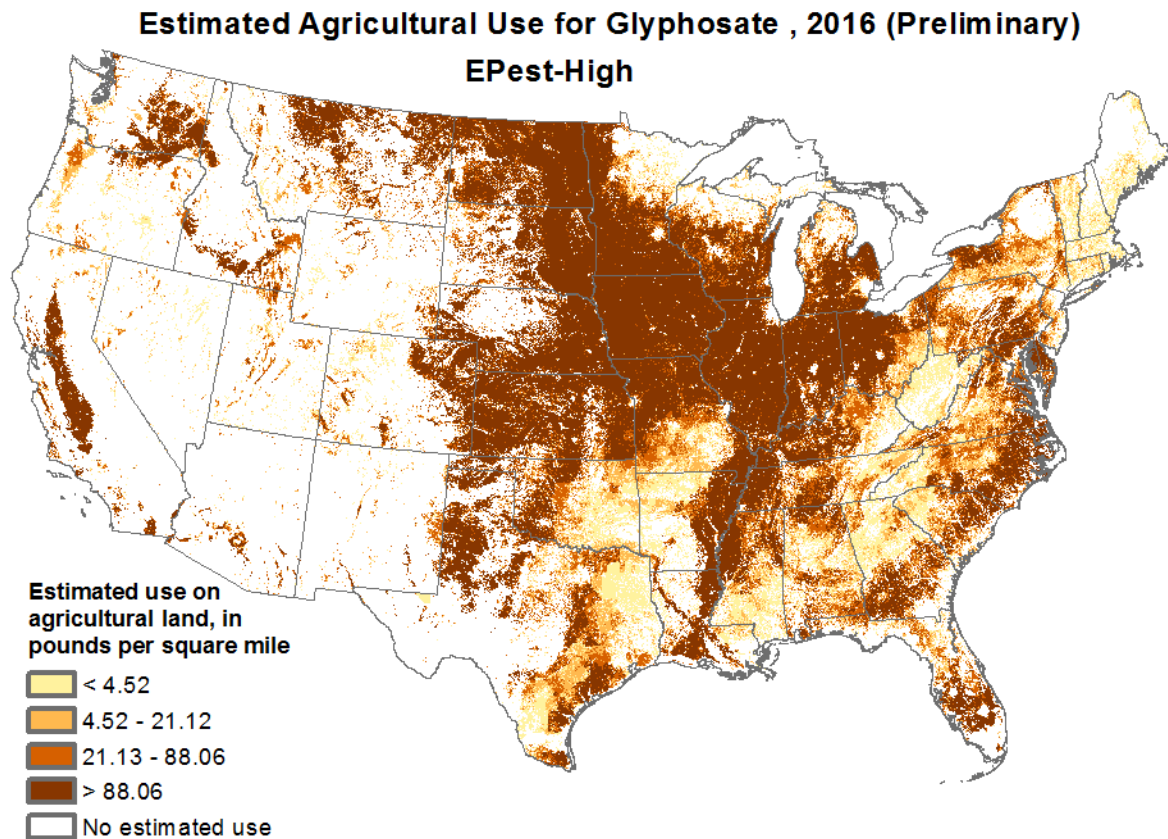
Monsanto engineered many food crops specifically to be used with Roundup.<sup>39</sup> These "Roundup ready" crops are designed to withstand the weed killer. The idea is that you spray the herbicide on the entire field, the weeds die, but the crops survive.

Lately, Roundup hasn't been getting the job done. Weeds have grown resistant, and these "super weeds" require more and more Roundup to kill.<sup>40</sup> Not surprisingly the response has been to increase the dosage of Roundup used, increasing the frequency of Roundup use, or combining Roundup with other herbicides.<sup>41</sup>



The result? Roundup, and generic versions of it, have become the most widely used agricultural chemical in history. And the amounts in use are truly staggering. Nearly 1.8 million tons of glyphosate have been used in the U.S. since its introduction in 1974. Worldwide, 9.4 million tons of the chemical have been sprayed onto fields as of 2014.<sup>42</sup>

For comparison, that's equivalent to the weight of water in more than 2,300 Olympic-size swimming pools. And in 2014 alone, there was enough used to spray nearly half a pound of glyphosate on every cultivated acre of land in the world.<sup>43</sup>



**Figure 2, Agricultural Glyphosate Use Map (2016),** *Source: [USGS Pesticide National Synthesis Project](#)*

The herbicide is actually starting to show up in our food and in our bodies. A recent study found traces of glyphosate in 93% of the urine tested.<sup>44</sup>In another recent survey [5], Moms Across America and Sustainable Pulse measured glyphosate levels in the urine of 85 US citizens: 17 were recruited in the streets of Washington DC; the others, volunteers among the members of Moms Across America, were spread across the country. Glyphosate was detected in 22 cases at an average concentration of 12.6 ppb.<sup>45</sup> The maximum of 18.8 ppb was measured in the urine of a woman in Oregon. Comparable levels have been detected in a survey performed on farming and non-farming families in Iowa.<sup>46</sup> Glyphosate was detected in the majority of samples, including more than 95% of the children's urine samples (maximum of 18 ppb).

In Europe, a survey by Friends of the Earth across 18 countries found glyphosate in 80 out of 182 urinary samples taken from volunteers.<sup>47</sup> Another European survey showed average urinary glyphosate levels of 5.4 ppb (maximum of 40 ppb).<sup>48</sup>

But how is glyphosate getting into our bodies? In the above study in Iowa, researchers compared the amount of glyphosate in farm and non-farming families. The researchers found the same level of glyphosate in children from both types of families. According to Bill Freese, senior scientist at Center for Food Safety, that study indicates that glyphosate is entering bodies not just from working on a farm, but from food, water, and beverages.<sup>49</sup>

And other studies discovered residues of the chemical in many foods, including corn and soy-based foods, as well as children's cereal.<sup>50</sup>

And the Roundup sprayed on rural, agricultural fields affects us all. One recent study by the U.S. government sampled waterways in 38 states, and found glyphosate in the majority of rivers, streams, ditches, and wastewater treatment plants tested.<sup>51</sup> It was also found in 70% of rainfall samples.<sup>52</sup>

Glyphosate and AMPA were frequently detected in streams in the American Midwest during the growing season.<sup>10</sup> In a monitoring program in Denmark, glyphosate and AMPA were washed out of the root zone of some types of soil and into drainage water in average concentrations that exceeded the EU permitted limit for drinking water (0.1 µg/l).<sup>11,12</sup>

While there is some risk of overspray from other farms, or contamination through rainfall or irrigation water, most of the glyphosate is used to control weeds on the ingredients in beer and wine. The use of glyphosate in beverages is substantial. Glyphosate can be sprayed by hand-sprayers, by tanks fitted like backpacks, and by air from planes.<sup>53</sup>

On conventional vineyards, a strip is sprayed on either side of the grape vines which are planted in rows, to kill weeds when the plants are dormant in late winter or early spring. This results in a thick strip of Roundup sprayed soil with grapevines in the middle.<sup>54</sup>

Due to this practice, the California Department of Pesticide Registry states that of the 57,237 pounds of glyphosate used just in Napa County in 2013, 50,417 pounds were applied on vineyards.<sup>55</sup> According to the California Department of Health, wine-making Napa County was in the top for the highest cancer rates for kids in California from 2008-2012.<sup>56</sup>

On farms, glyphosate is sprayed not only on "Roundup Ready" crops, but also to kill weeds in ditches near fields, and to "kill down" crops at the end of the growing season so they can be harvested faster. Glyphosate kills beer-ingredient crops like barley and wheat, drying it out so that it can be harvested sooner than if the plant were allowed to die naturally. This is one way that glyphosate can be introduced in beer.<sup>57</sup>

Glyphosate cannot be used in organic vineyards or organic barley,<sup>58</sup> so the presence of glyphosate/Roundup in the organic beer and wine is obviously unexpected. It is possible that airborne drift from nearby vineyards contaminated the organic crops, as glyphosate is capable of drifting several hundred feet.<sup>59</sup>

It may also be possible that glyphosate/Roundup could also appear in organic fields which were conventionally managed and then converted to organic. According to some scientific studies, residues of glyphosate/Roundup can remain in the soil for years.<sup>60</sup>

Further, due to the ubiquitous nature of Roundup, it is possible that Roundup is entering organic products through irrigation water, rainwater, or other points of entry unforeseen by organic growers. It is difficult to avoid the most commonly used herbicide in the world.

## **Food and Beverage Tolerances and Risk Assessments**

The highest level of glyphosate found in PIRG's samples was 51 ppb. Is this a level that should concern consumers?

Glyphosate residues are allowed on over 150 different food and feed crops by the EPA at levels of 0.2 to 400 ppm (200 to 400,000 ppb).<sup>61</sup> The EPA does not currently have a limit on beer or on wine.

The state of California's Office of Environmental Health Hazard Assessment, or OEHHA, has also proposed what is known as a "No Significant Risk Level" for glyphosate. They set the no significant risk level at 1.1 milligrams per day for an average adult of about 154 pounds.<sup>62,63</sup>

California's level represents an increased lifetime risk of cancer of one in 100,000 for an average adult. According to Dr. Alexis Temkin, Ph.D., toxicologist, for many cancer-causing drinking water contaminants, OEHHA's lifetime risk factor is set at one in 1 million. Based on this information, Dr. Temkin calculated that a one-in-a-million cancer risk would be posed by ingestion of 0.01 milligrams of glyphosate per day for children, with a higher tolerance for adults.<sup>64</sup>

To reach this dose of .01 mg per day, one would need to drink a glyphosate level of 160 ppb. The samples collected by PIRG contain much lower concentrations of glyphosate than 160 ppb. However, as some people drink a large quantity of beer and wine in one sitting, people should be cautious of the levels of glyphosate in their beer and wine.

To add to the complexity, German scientists have shown that 0.1 ppb of glyphosate has the potential to destroy beneficial gut bacteria while pathogenic gut bacteria were resistant.<sup>65</sup> Further, 0.1 ppb of glyphosate has also been shown to stimulate the proliferation of certain types of breast cancer cells.<sup>66</sup>

While we consider the amounts of glyphosate in beer and wine to be relatively low compared to amounts found in items like cereal, consumers should still be aware of the small risk entailed in consuming glyphosate.

## **Results**

Below are the results of our testing. We tested 15 products: 5 wines and 10 beers. The wine brands tested included Beringer, Barefoot and Sutter Home. Beer brands tested included Budweiser, Coors, Miller Lite, Sam Adams, Samuel Smith Organic, and New Belgium.

Notable findings:

- Of the 20 samples, 19 contained glyphosate. The highest level of glyphosate found was in Sutter Home wine, at 51 ppb.
- Our results also showed that 3 out of 4 organic beers and wines contain glyphosate. Although glyphosate is not allowed or used in organic farming, several types of organic products were contaminated, such as Samuel Smith Organic (at 3.5 ppb). Inkarri Estate organic wine contained 5.2 ppb.
- All large, conventional brands such as Coors and Miller Lite showed glyphosate levels of a least 25 ppb.
- One brand, Peak Beer, did not contain detectable glyphosate.

## Wines:

### 1. Sutter Home Merlot

U.S. vineyard (2018)

4 pack, 187 mL bottles

Glyphosate concentration: **51.4 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

### 2. Beringer Estates Moscato

U.S. vineyard (2018)

750 mL bottles

Glyphosate concentration: **42.6 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

- 3. Barefoot Cabernet Sauvignon**  
U.S. vineyard (2018)  
4 pack, 187 mL bottles  
Glyphosate concentration: **36.3 ppb**  
Non-organic



Photo credit: Kara Cook, U.S. PIRG

- 4. Inkarrri Estates Malbec: Certified Organic**  
Argentina (2016)  
750 mL bottles  
Glyphosate concentration: **5.3 ppb**  
Certified Organic



Photo credit: Kara Cook, U.S. PIRG

- 5. Frey Organic Natural White Blend**  
U.S. (2017)  
750 mL bottles  
Glyphosate concentration: **4.8 ppb**  
USDA Certified Organic



Photo credit: Kara Cook, U.S. PIRG

## Beers:

### 1. Coors Light

U.S. beer (2018)

6 pack, 500 mL can

Glyphosate concentration: **31.1 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

### 2. Tsingtao Beer

Chinese beer (2017)

4 pack, 640 mL bottle

Glyphosate concentration: **49.7 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

### 3. Miller Lite

U.S. beer (2018)

6 pack, 375 mL bottle

Glyphosate concentration: **29.8 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

### 4. Budweiser

U.S. beer (2018)

6 pack, 440 mL bottle

Glyphosate concentration: **27.0 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

**5. Corona Extra**

Mexican beer (2017)

6 pack, 355 mL bottle

Glyphosate concentration: **25.1 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

**6. Heineken**

The Netherlands beer (2018)

6 pack, 355 mL bottle

Glyphosate concentration: **20.9 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

**7. Guinness Draught**

Ireland beer (U.S. bottler and distributor) (2018)

4 pack, 440 mL bottle

Glyphosate concentration: **20.3 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

**8. Stella Artois**

Belgium beer (2017)

6 pack, 355 mL bottle

Glyphosate concentration: **18.7 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

**9. Stella Artois Cidre**

Belgium cider (2018)

6 pack, 355 mL bottle

Glyphosate concentration: **9.1 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG

**10. Ace Perry Hard Cider**

U.S. cider (2018)

6 pack, 650 mL bottle

Glyphosate concentration: **14.5 ppb**

Non-organic



Photo credit: Kara Cook, U.S. PIRG



- 11. New Belgium Fat Tire Amber Ale**  
U.S. beer (2018)  
6 pack, 350 mL bottle  
Glyphosate concentration: **11.2 ppb**  
Non-organic



Photo credit: Kara Cook, U.S. PIRG

- 12. Sam Adams New England IPA**  
U.S. beer (2018)  
4 pack, 475 mL can  
Glyphosate concentration: **11.0 ppb**  
Non-organic



Photo credit: Kara Cook, U.S. PIRG

- 13. Sierra Nevada Pale Ale**  
U.S. beer (2018)  
6 pack, 350 mL can  
Glyphosate concentration: **11.8 ppb**  
Non-organic



Photo credit: Kara Cook, U.S. PIRG

- 14. Samuel Smith's Organic Lager**  
U.K. beer (2017)  
singles, 550 mL bottle  
Glyphosate concentration: **5.7 ppb**  
Organic



Photo credit: Kara Cook, U.S. PIRG

### 15. Peak Beer Organic IPA

U.S. beer (2018)

singles, 350 mL bottle

Glyphosate concentration: **no-detected level**

Organic, USDA-certified



Photo credit: Kara Cook, U.S. PIRG

## Conclusion and Policy Recommendations

The glyphosate tests on the 15 beer and wine samples do not constitute a full scientific study of how much glyphosate is currently in the beverage industry. However, these tests give consumers compelling evidence that the beer and wine industry largely sources materials which use glyphosate- based herbicides.

The levels of glyphosate we found are not necessarily dangerous, but are still concerning given the potential health risks. What is surprising is that glyphosate found its way into almost every type of beer and wine tested, including organic products. That indicates that consumers who want to avoid glyphosate, due to its probably health effects, would have a difficult time doing so. Considering the ubiquity of glyphosate found in many foods tested by other scientists and groups, and the amount of glyphosate sprayed throughout the country, people are constantly exposed to glyphosate.

U.S. PIRG Education Fund makes the following recommendations to **Regulators**:

- U.S. EPA should reconsider its food tolerance level for glyphosate using the California OEHHA safety limits as a guide.<sup>67</sup> U.S. EPA should also set limits for glyphosate in beer and wine, as currently there is no safety limit for beverages.
- U.S. Department of Agriculture (USDA) should do glyphosate testing of beer and wine before it hits stores. Currently, the USDA does not test any product for glyphosate, including failing to test food products. This is despite the fact that USDA is responsible for testing produce for other pesticides, and frequently tests foods for similar weed killers and other pesticides. The USDA should revisit their food and drink testing procedures and start testing products, particularly organic products, for glyphosate.

- U.S. EPA should reconsider the safety of glyphosate due to increasing scientific evidence showing that glyphosate is a probable human carcinogen. Using the precautionary principle, the EPA should ban the use of glyphosate unless and until it can be proven safe.

U.S. PIRG Education Fund makes the following recommendations to **vintners and brewers**:

- Conventional growers should stop using the “kill down” method for drying out wheat and barley at the end of the growing season.
- Conventional growers should stop spraying glyphosate on and near fields, in between vines, and in nearby ditches.
- Conventional growers should explore using cover crops and other sustainable farming methods to improve their soil and to help with weed control.
- Organic growers should ensure that there is a wide buffer in between their property and conventional growers nearby.
- Organic growers should test their soil for glyphosate contamination.
- Brewers and vintners should test their products for glyphosate contamination before bottling and/or canning, as there may be other sources of contamination (such as rainwater) that would be difficult to detect otherwise.

U.S. PIRG Education Fund makes the following recommendations to **consumers** who wish to avoid glyphosate or Roundup in their beverages:

- Ask stores, breweries, and vineyards what their glyphosate policy is, and encourage them to look for sustainable ways of growing their produce.
- Lower your overall exposure to glyphosate by not spraying it in your home or garden. [See **Appendix 2** for ideas on how to garden without Roundup.]
- Sign our petition to the EPA asking it to ban the use of Roundup/glyphosate unless and until it can be proven safe.

- When possible, buy organic. While there may still be some contamination, the amounts of glyphosate found in organic samples is much lower than in conventional beer and wine.

## **Methodology**

The methodology of testing was modeled on guidelines for testing food and beverages for pesticides, a modification of the method described in Chamkasem, Narong, Cynthia Morris, and Tiffany Harmon: “Direct Determination of Glyphosate, Glufosinate, and AMPA in Milk by Liquid (2016).” Limit of Quantitation (LOQ) and Limit of Detection (LOD) are sub-part per billion for this method and are determined for each sample.

All 20 products were purchased in Denver, Colorado or in California and shipped to our laboratory in San Francisco, California, in sealed containers.

Here is the procedure followed by the lab:

“To detect glyphosate, an enzyme linked immunosorbent assay (ELISA) was used. The sample along with a glyphosate specific antibody is added to a well coated with goat antiRabbit antibody and incubated for 30 minutes. Then a glyphosate enzyme conjugate is added. A competition occurs between glyphosate that is present in the sample and the enzyme labeled glyphosate analog for the antibody binding sites in the well. The wells are washed and a color solution is added. The color solution causes a color change in the wells containing the enzyme labeled glyphosate analog. Since the labeled glyphosate was in competition with the unlabeled glyphosate in the sample the color development is inversely proportional to the concentration of glyphosate in the sample. The wells are read at 450nm to determine absorbance.

“Results are calculated based on a standard curve. The results are then adjusted based on the extraction procedure and final dilution.”

## **ENDNOTES**

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<sup>1</sup> See, e.g., Alexis Temkin, “[Breakfast with a dose of Roundup?](#)” Aug. 16, 2018, Environmental Working Group; Ben & Jerry’s Statement on Glyphosate, accessed on Nov. 21, 2018. *Available at:* <https://www.benjerry.com/about-us/media-center/glyphosate-statement>

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