Homebrew toxicology: Debunking the hidden dangers of chemicals in your brew system

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But first...

This presentation takes a scientific approach, However, this is the same advice I give to my family, friends and anyone who asks me about homebrewing

The goal is not to…

make everyone here a toxicologist

In the words of Arnold Lehman
“You too can be a toxicologist in two easy lessons,

The goal is not to…

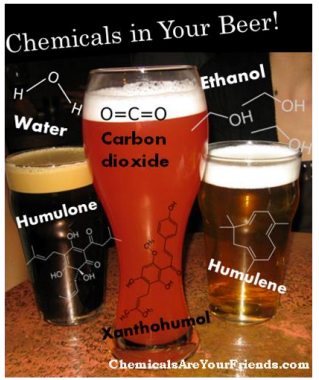
make everyone here a toxicologist

In the words of Arnold Lehman
“You too can be a toxicologist in two easy lessons, each of 10 years.”

The goal of this presentation

is to give you some tools to use to evaluate your homebrew system

- How to determine safety (or risk)
- General advice for reducing risk
- Examples of common materials



Danger is lurking (?)

The Internet full of cautions about using different materials in your system:

- Mash tun coolers
- Plastic fermenters, hoses and tubing
- Cleaners and sanitizers

But do we really need to be concerned?

Homebrew toxicity

Consumption of homebrew is definitively linked to toxicity:

- Nausea
- Headache
- Dehydration
- Disorientation

Ethanol toxicity

- Concentration in beer can be > 20% (200,000 ppm)
- Effects can be both short-term (nausea, headache, etc.) as well as long-term (linked to cancer, cirrhosis, reproductive effects)
- Homebrewers are aware of these risks and accept them because they are offset by the enjoyment beer brings to them

Risk from other chemicals

Compared to ethanol, other chemicals present in homebrew are:

- Less hazardous, and/or
- Present at lower concentrations

If you aren’t worried about ethanol, you shouldn’t be worried about other chemicals

Risk = Hazard X Exposure

Toxicology 101: Lesson #1

Risk requires both hazard and exposure:

- There is no risk from materials that are not hazardous
- There is no risk from materials you are not exposed to

Risk = Hazard X Exposure

No Hazard = No Risk

Grass snake (*Natrix natrix*)

- Non-venomous (No hazard)
- Lives in your backyard (High exposure)
- **No Risk**

No Exposure = No Risk

King cobra (*Ophiophagus hannah*)

- Highly venomous (High hazard)
- Lives in the zoo (No exposure)
- **No risk**

Determining hazard

To determine the true hazard of a chemical:

- Consider all available data
  - Give additional weight to the most relevant studies
    - For example, animal studies are more relevant than cell culture studies
  - Give additional weight to studies with proper design
    - For example, relevant concentrations and proper controls used

PET: Polyethylene terephthalate

The most relevant safety study:

- Rats fed a diet of 5% PET for 90 days had no toxicity
  - Correlates to 2.8 g of PET per kg body weight

Vast majority of studies support conclusion that PET is non-hazardous

Merski et al., 2008. Int J Toxicol 27: 387-395

PET: Human safety estimate

The concentration of 2.8 g of PET per kg body weight is safe

- Human weighing 86 kg (190 lbs)
- Consuming 240 g of PET per day would be safe
  - A cup of sugar weighs ~ 200 g
  - You could eat a 1 kg bucket every 4 days without worrying about toxicity

Plastics are not hazardous

The PET example is representative of plastics

- Plastics are huge polymers that are not bioavailable

- Other chemicals may be present in small concentrations, but:
  - Most are consumed during the polymerization reaction
  - Anything else will rinse out easily

Determining hazard

- Consider all information, but
- Give more weight to the best studies
- Ethanol is more hazardous than most chemicals found in beer

Determining exposure

- How much of the chemical could end up in a typical batch of homebrew?
  - Where would the chemical come from?
  - How much chemical could end up in finished beer?
- How much homebrew would we expect someone to consume?
  - The exposure to a chemical in beer is directly related to how much beer an individual consumes

“The dose makes the poison”

Toxicology 101: Lesson #2
Everything is toxic at some level, so exposure is crucial to risk

- Botulinum toxin
  - Toxic at 1-2 nanograms per kg body weight (one billionth of a gram)
- Water
  - 6 L in 3 hours fatal in 2007 incident

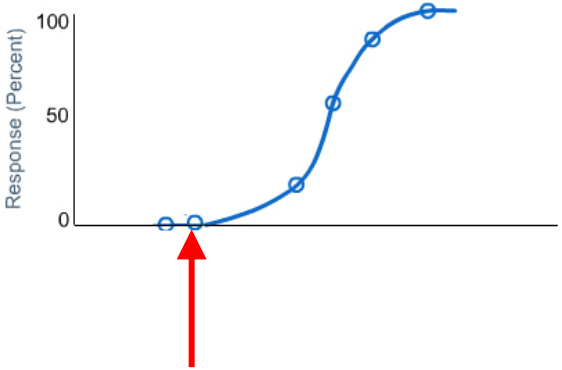
Paracelsus
1493 - 1541

“The dose makes the poison”

It also means that there is a safe amount of every chemical

In our PET example, 240 g was safe for our homebrewer

- Exposure to 240 g is just as safe as exposure to 2 g



Threshold of toxicity (240 g)
Exposure to doses below the threshold do not result in toxicity

The ethanol dose response

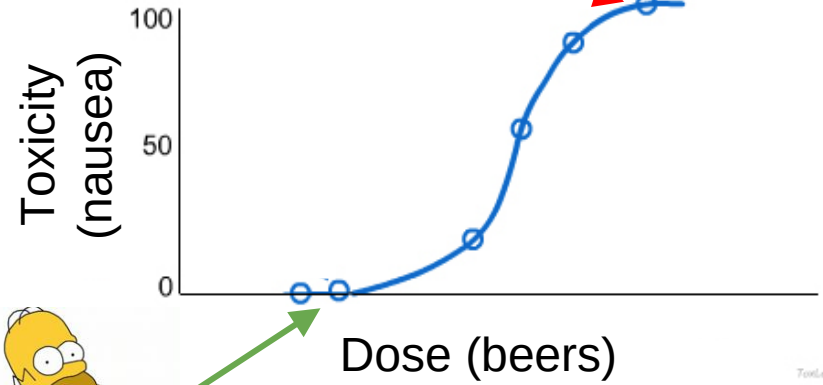
Ethanol is a good example of the threshold effect:

- 10 beers = Nausea
- 1 beer = No nausea

In this example, 1 beer is safe

- Consumption of < 1 beer is <u>not</u> any more safe than 1

10 beers



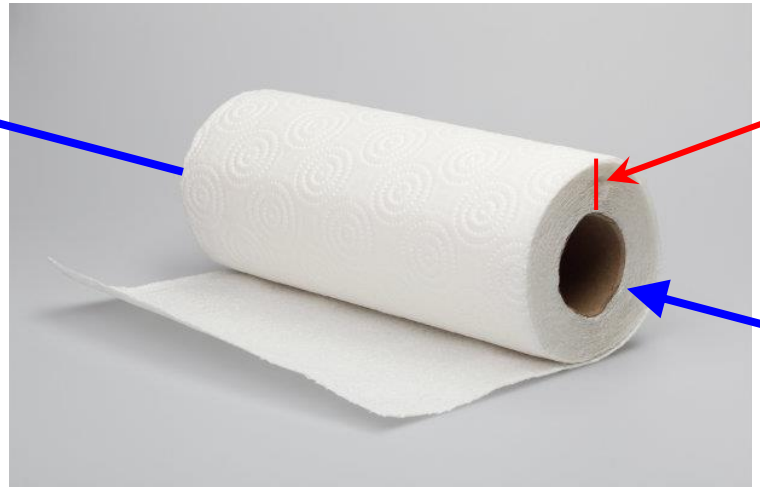
1 beer

Lead in brass fittings

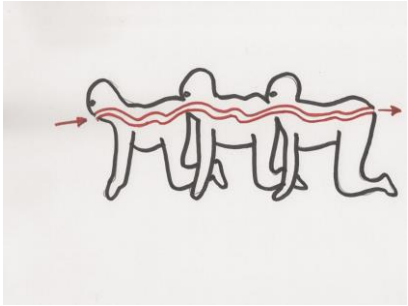
Lead is present in some brass fittings, but not necessarily in finished beer:

- An oxide layer prevents lead from leaching out of the fitting
- The yeast cake absorbs metals including lead
- Low exposure means low risk

No absorption = No exposure



Large chemicals, like polymers, go right through the tube and never come in contact with the good stuff



Determining exposure

- The dose makes the poison
  - Everything is toxic if you consume enough of it
    - Even water!
  - Everything has a “safe” level
    - Even botulinum toxin!
- Exposure to ethanol (> 200,000 ppm) is much greater than other chemicals in beer
  - Other examples: lead (< 0.01 ppm), iodine from iodophor (0.25 ppm), bleach (< 2 ppm), acetaldehyde (15 ppm), diacetyl (5 ppm)

Determining risk

Putting it all together with an example: Dimethylpolysiloxane

- Anti-foaming agent: Fermcap-S
  - What is the hazard?
  - What is the exposure?
  - What is the risk?

Fermcap-S: Hazard

Lifetime study in rats:

- 0.15 g/kg was safe (no toxicity)

Homebrewer relevance:

- 86 kg homebrewer, 13 g/day would be safe

Fermcap-S: Exposure

Recommended use: 2 drops per 5 gallons (20L)

2 drops
0.5 g

0.5 g/20 L
0.025 g/L

0.009 g/glass
(12 oz/350 mL)

Fermcap-S: Risk

Homebrewers have nothing to fear

- Safe level: 13 g/day
- Exposure: 0.009 g/glass
- Would need to drink > 1400 glasses of beer per day day exceed the safe level

Low hazard, Low exposure, Low risk

Being careful is good

There are simple steps that can further reduce risk without making brewing inconvenient:

1. Use materials for their intended function
2. Look for food-grade materials
3. Use common sense
4. Relax and have a homebrew

Use materials as intended

Start by using equipment/materials specifically designed for homebrewing

It doesn’t mean other things are not safe, just that they haven’t been evaluated for this use

Use food-grade materials

Homebrewers are resourceful, when looking for alternatives, seek out things used with food/water:

Bakery buckets

Water coolers

Jerry cans

Camper hose

Water jugs

Use common sense

Let your senses be your guide:

- Hose water smell like plastic after sitting in the sun?
  - Run a few gallons out before using
- Worried about your well water?
  - Invest in a carbon filter

Condition your equipment

Plastic:

- Give your new equipment a few rinses with hot water

Metal:

- John Palmer gives advice on how to condition metal equipment

Be skeptical about warnings

Attention grabbing articles often:

- Overinterpret the hazard of a compound
  - Usually highlighting results from a single study with questionable relevance (e.g. cell culture studies)
- Fail to provide context around whether exposure is relevant
  - Assuming any exposure results in risk

Good sources of information

These sources evaluate all available data:

- US National Toxicology Program (NTP)
  - http://ntp.niehs.nih.gov/
- US Agency for Toxic Substances and Disease Registry (ATSDR)
  - http://www.atsdr.cdc.gov/
- European Food Safety Authority (EFSA)
  - http://www.efsa.europa.eu/
- US Environmental Protection Agency (EPA)
  - http://www.epa.gov/IRIS/
- Joint FAO/WHO Expert Committee on Food Additives (JECFA)
  - http://www.fao.org/food/food-safety-quality/scientific-advice/jecfa/en/

Relax and have a homebrew

Sláinte!

You've already decided you accept the benefits and drawbacks of ethanol consumption - Don't waste time worrying about chemicals in your homebrew that present far less risk than ethanol

Instead focus that energy on the best part of this hobby - Making tasty beer!

Some common questions

With the last few slides, I'll go over some more of the common questions that I have received

Isn’t anything toxic?

<u>Hops and Dogs Don’t Mix!</u>

Hops are not toxic to humans

However, there are many documented cases of hops causing toxicity in dog

Picnic cooler mash tun?

- No concerns of toxicity
  - Made of food grade plastic
  - Withstand mash temperatures
- Extra precautions:
  - Taste and smell water for off flavors
  - Before first use, give it one or two rinses with hot water

Garden hoses?

- No concerns of toxicity
  - Transporting unheated water
  - Withstand mash temperatures
- Extra precautions:
  - Taste and smell water for off flavors
  - Run off stagnant water
  - Add a carbon filter after hose

Cleansers?

Whether specifically designed for cleaning brewing equipment or not:

- Intended use is cleaning of food-contact surfaces
- Rinse thoroughly after using
- Low toxicity, Low exposure
- No concern

Stay away from scented!

Sanitizers?

Sanitizers are approved after a scientific review that considers:

- All available data on the compound
- Worst-case estimates of exposure

No concern of toxicity, remember:

- No need to rinse
- Use according to instructions

More is not always better!

Bleach?

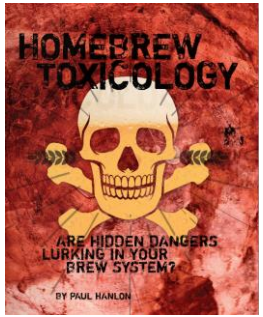
Bleach is approved as a sanitizer for food-contact surfaces

- Use according to instructions (1 tbsp per gallon)
- No need to rinse
- Use caution (corrosion, off-flavors)

No concern for toxicity of the bleach itself, or the generation of other chemicals

Thanks!

For more information, check out:



- Zymurgy - May/June 2015 Issue

- Basic Brewing Radio - Three episodes between Nov 2013 - Feb 2014

Questions?