Arsenic in Wine

UC Davis Fact Sheet
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Facts on Arsenic in Food and Beverages Including Wine

- Arsenic (As) is naturally found in soil and ground water. As such it is taken up by plants and can be found in plant tissues.
- Unlike some other common minerals, Arsenic is not used by the human body for normal function.
- Arsenic levels vary over four orders of magnitude in foods (<1 μg/kg to >10,000 μg/kg) (*1-3*)
- Arsenic is found in many forms (or species) in nature. Toxicity depends on the form of arsenic that is present as well as the matrix (air, food, water), the mode (inhalation, ingestion) and amount of exposure. The most bioavailable forms are the most toxic (i.e., bioavailability is determined by the amount that is ingested that crosses the gastrointestinal epithelium or lining and is available for distribution to internal tissues/organs) (*4*).
- Speciation (the variety or distribution of arsenic species present in a food or beverage) is critical for assessing potential toxicity and consumer exposure (*5*). Any regulatory limits should take into account speciation analysis.
- The main arsenic species in water, inorganic As III and As V, are the most toxic forms. A variety of organic As species are found in foods/beverages; these are usually less toxic than inorganic forms (although toxicity of many organic As species is still unknown). Without understanding speciation, measurements of As may overestimate the amount of the inorganic form that is present (*5*) and therefore overestimate toxicity.
- Speciation analysis uses analytical laboratory equipment to separate the different As species (e.g. inorganic vs organic); this is done chromatographically (using Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC), and Capillary Electrophoresis (CE)) followed by elemental identification and detection. Inductively coupled plasma mass spectrometry (ICP-MS) is the most common means of identification and detection.
- Current regulatory levels:
  - The US EPA limit for total inorganic As in **water** is 10 μg/L (*6*). Since 1 L of water weighs approximately 1 kg, this limit can also be found expressed as 10 μg/kg or 10 ppb.
  - There are no maximum levels for arsenic in food/wine in the US.[1]

[1] An "action level" of 10 μg inorganic Arsenic/L for apple juice has been set by the EPA (http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm360466.htm).

- There are no maximum levels for arsenic in food at the EU level (*7*). However, the FAO-WHO Codex Alimentarius Committee has adopted a maximum level for inorganic arsenic in polished rice of 200 μg/L (*8*).
- The International Organisation of Vine and Wine (OIV) has established maximum acceptable limits of total inorganic As in wine of 200 μg/L (*9*).
- The permissible limit for wines sold in Canada is 100 μg inorganic As/L (*10*).

- In humans, exposure limits and regulatory levels for inorganic As are based on either a Reference Dose which is defined as an "estimate of the daily oral exposure in the human population that is likely to be without appreciable risk of non-cancer effects during a lifetime" (*11*) or on a Provisional Tolerable Weekly Intake (PTWI), defined as a benchmark dose that may be of concern for increased incidence of cancer (*7, 11*).
  - The US EPA has established a Reference Dose of inorganic As as 0.3 μg/kg body weight per day (*5, 11*).
  - The 2010 Joint FAO/WHO Expert Committee on Food Additives (JECFA) determined a PTWI of 3.0 μg inorganic As/kg body weight per day as the benchmark dose lower confidence limit for a 0.5% increased incidence of lung cancer (*7*).
  - Based on a comprehensive survey of food consumption in 17 European countries, overall dietary exposure was below the PTWI. In this study water was a significant source as were non-rice, grain-based processed products (*7*).
  - A recent study of dietary exposure to inorganic As in the US indicated that overall exposures were below the established Reference Dose (*11*). In this study, marine sources were a significant source of exposure, followed by grains, legumes, and seeds.
- Levels reported in wines:
  - Mean inorganic As concentrations in wines ranged from 3.9 μg/kg (Lower Bound) to 7.6 μg/kg (Upper Bound), based on an analysis of 1047 wines from 21 countries in the European Union (*7*). Data were initially reported as total As and converted to inorganic As using a standard correction factor of 70%.
  - No data is currently available for California wines in a refereed (peer-reviewed) journal. However, measurements have been reported in the press for US wines performed by governmental agencies such as the LCBO in Canada in which they are reported to be uniformly below regulatory limits. Full description of the methods used for these measurements were not reported.

Useful Examples of Calculations for Arsenic Exposure from Wine Consumption

Assume that inorganic arsenic exposure from all foods (besides wine) is 0.05 μg/kg body weight/day *(11)*. Profiling a very heavy wine drinker, let's assume a 70 kg (154 pound) person consumes five 5 oz. glasses of wine per day. Average daily consumption of wine would be 25 ounces per day, or a total of nearly 0.75 kg of wine per day or about 1 standard (750 mL) bottle of wine per day for that single consumer. At an average concentration of inorganic As of 10 ppb (higher than the average found in any published study), this would result in an average daily exposure, adjusted for body weight, of about 0.11 μg/kg body weight/day inorganic As just from the wine. Total dietary exposure to inorganic arsenic (food and wine) would then be 0.16 μg/kg body weight/day, still well

below the EPA Reference Dose of 0.3 μg/kg body weight/day. It would take an AVERAGE level of 23 ppb inorganic As in wine, in the case of this very heavy drinker, to still reach the 0.3 μg/kg body weight/day level. This scenario would be very unlikely.

A moderate drinker (again 70 kg or 154 pounds) consuming two 5 oz glasses of wine per day with 10 ppb in inorganic arsenic would have an average daily exposure, adjusted for body weight, of about 0.04 μg/kg body weight/day from wine alone or 0.09 μg/kg body weight/day including average intake with food—far below the EPA Reference Dose. Even at 50 ppb inorganic arsenic—the highest reported in the press recently—this level of moderate consumption including food would still be well beneath the guidelines set by the EPA.

Based on these calculations, normal wine consumption contributes a very modest amount of inorganic arsenic to the diet, and even the highest levels reported in the press recently (50 ppb) would not raise arsenic intake above accepted levels with moderate consumption**.** Average adult exposure to inorganic As through food, according to data from UC Davis *(11)*, is about 0.05 μg/kg body weight/day. ***It would take inordinately high consumption of wine that coincidentally had high levels of arsenic to come close to the 0.3 μg/kg body weight/day level of concern set by the EPA*** and ten times higher consumption to reach the PTWI level.

Recommendations:

- If regulatory policy is to be established in the US and California, maximum levels consistent with those of other countries, such as Canada, should be used. Regulatory policy should be based on speciation analysis—and, as much as possible, data that relates health impacts to speciation analysis.
- Additional research should be performed to evaluate forms of As present in wines.
    - Factors that both increase and decrease total As and inorganic As levels in grapes should be evaluated, e.g., As levels in water/irrigation and soil, and cultivar and rootstock effects on uptake and speciation.
    - Factors that both increase and decrease total As and inorganic As levels during winemaking should be evaluated, e.g., water sources, soil contamination, winery equipment, filtration, fining, etc.

References

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