What is the difference between organic and inorganic arsenic?

When determining arsenic content of foods or beverages it is important to distinguish between the forms of arsenic. "Total arsenic count" can be misleading, as one must always pay attention to the type that matters most.

Joe Schwarcz PhD (/oss/articles-by-author/Joe Schwarcz PhD) | 30 Aug 2018

Atoms of arsenic can combine with atoms of other elements to form a variety of compounds. These can be divided into two categories, "inorganic" and "organic." In this case, the term "organic" is used in its proper chemical sense, referring to molecules that have a framework of carbon atoms. In an "organic" arsenic compound, the arsenic atom is attached to a carbon that may, for example, be part of a sugar molecule such as ribose. This "organic" variety is more complicated in structure, but it is harmless. "Inorganic" arsenic compounds, on the other hand, do not contain carbon and are generally simple molecules, such as arsenic trioxide. These compounds are highly toxic.

Arsenic trioxide, meriting the name of "inheritance powder", is the one that historically has been used as a lethal poison. Groundwater can contain inorganic arsenic in the form of arsenite or arsenate, in which arsenic is bound to oxygen atoms. Drinking such water can pose a serious health risk, as has been

demonstrated in Bangladesh where the water in numerous wells has been found to contain arsenic at concentrations hundreds of times greater than 10 parts per billion - the number that has been deemed to be the maximum safe level. Ironically, theses very same wells were bored in the first place because so many people were dying from gastrointestinal diseases caused by drinking pond and river water contaminated by sewage. Epidemics of skin blemishes, lung disease, skin cancer, and liver failure have already afflicted people drinking contaminated well water. By contrast, organic arsenicals, such as arsenobetaine, the most abundant arsenic compound in seafood, are relatively non-toxic. That's because the arsenic atoms are firmly tied up and unavailable for bonding with important biomolecules such as proteins.

The source of both organic and inorganic arsenicals are naturally occurring minerals, with arsenopyrite (FeAsS), realgar (As4S4) and orpiment (As2S3) being examples. As these erode, they react with moisture and oxygen to form arsenites and arsenates that are water soluble and consequently end up in both surface and groundwater. In surface waters, these can be absorbed by algae that then convert them to arsenosugars, arsinolipids and arsenobetaine.

Fish and other forms of marine life feed on these algae and concentrate the arsenic compounds. However, due to the relatively low toxicity or organic arsenicals, there is not much worry about arsenic in seafood. Rice, on the other hand, presents a different story. It grows in flooded paddies where the water can harbour inorganic arsenicals that are readily absorbed into the growing plant and are passed into the grain. The amount of arsenic that ends up in rice depends on the local geology. California rice tends to be very low in arsenic.

Obviously, when determining arsenic content of foods or beverages it is important to distinguish between the forms of arsenic. "Total arsenic count" can be misleading, as was demonstrated by the concern over apple juice, when results revealed on the *Dr. Oz Show* seemed to indicate unacceptable high levels of arsenic, panicking young moms. A proper analysis by the Food and Drug Administration, however, found that the concentration of inorganic arsenic, the one that matters, was within acceptable levels. Regulations for arsenic in apple juice are now in effect and have to be less than 10 ppb, the same as for drinking water.

At one time, the toxicity of inorganic arsenic compounds made them useful in the battle against insects and rodents. For example, copper acetoarsenite, first made around 1814 by reacting arsenic trioxide with copper acetate, found immediate application as a rodenticide. It was used to kill rats in the sewers of Paris, hence its common name of "Paris Green." During the Second World War it was sprayed from airplanes to kill mosquitoes in an attempt to control malaria in Italy. Due to toxicity concerns for people, arsenic insecticides and rodenticides have now been relegated to history books .

Keywords:

arsenic (/oss/category/tags/arsenic) organic (/oss/category/tags/organic) inorganic (/oss/category/tags/inorganic) toxicity (/oss/category/tags/toxicity)

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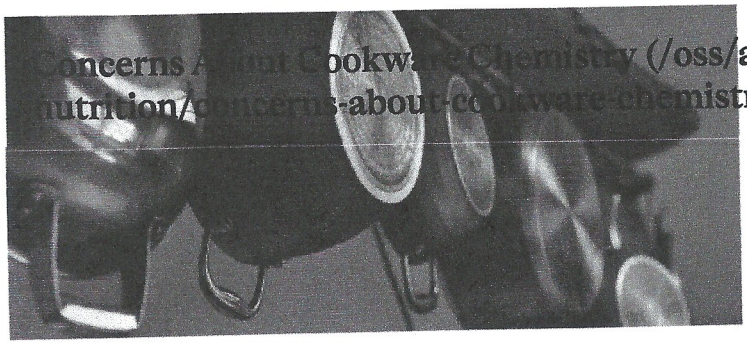

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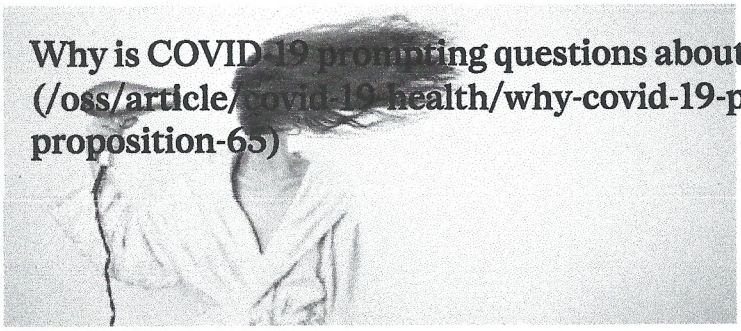

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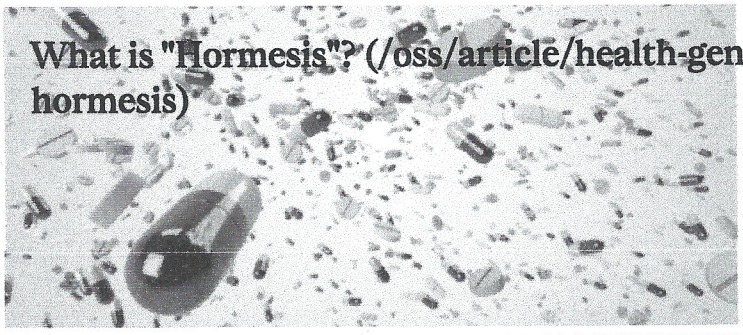

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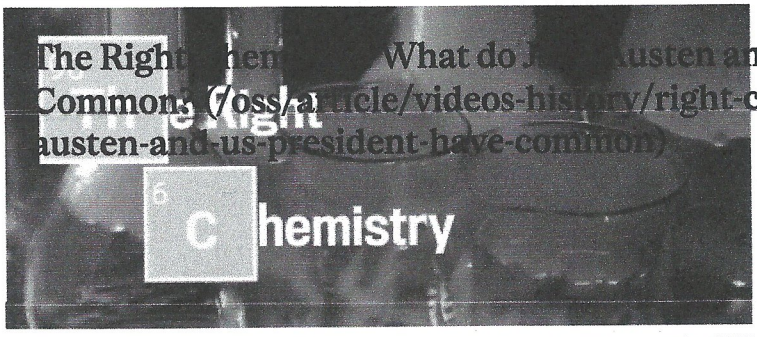

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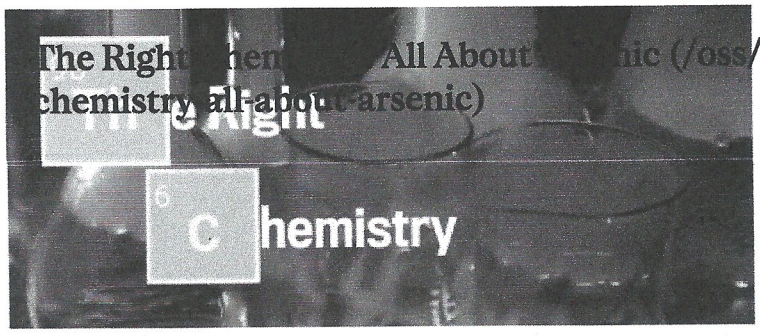

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