



Scientific Facts on **Arsenic**

Source document:

IPCS (2001)

Summary & Details:

GreenFacts (2004)

Context - Arsenic is a poisonous substance, which is released both from certain human activities and naturally from the Earth's crust.

Humans may be exposed to arsenic mainly through food and water, particularly in certain areas where the groundwater is in contact with arsenic-containing minerals.

To what extent can arsenic exposure affect human health or the environment?

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This Digest is a faithful summary of the leading scientific consensus report produced in 2001 by the International Programme on Chemical Safety (IPCS): "*Environmental Health Criteria for Arsenic and Arsenic Compounds (EHC 224)*"

The full Digest is available at: <http://www.greenfacts.org/en/arsenic/>



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- Level 3 consists of the Source document, the internationally recognised scientific consensus report which is faithfully summarised in Level 2 and further in Level 1.

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1. What is arsenic?

1.1 Arsenic is a natural element which behaves like a metal. It is present in the environment both naturally and due to certain human activities. It has many different forms. It can exist in inorganic or organic form, inorganic arsenic being generally considered more toxic.

1.2 Arsenic can be measured by a variety of laboratory methods. Some of these can distinguish between different forms of arsenic and some methods allow very small amounts to be measured accurately.

2. Where does environmental arsenic come from?

2.1 Arsenic is found in the natural environment in some abundance in the Earth's crust and in small quantities in rock, soil, water and air. It is present in many different minerals. About one third of the arsenic in the atmosphere comes from natural sources, such as volcanoes, and the rest comes from man-made sources. Due to natural geological contamination, high levels of arsenic can be found in drinking water that has come from deep drilled wells. This is particularly true for Bangladesh.

2.2 Industrial processes such as mining, smelting and coal-fired power plants all contribute to the presence of arsenic in air, water and soil. Environmental contamination also occurs because it is used in agricultural pesticides and in chemicals for timber preservation.

2.3 Arsenic occurs in different forms and some is transported between different parts of the environment where it may change its form. Arsenic in weathered rock or soil can be picked up and moved by the wind and water. Many arsenic compounds bind to soil and only move short distances when water percolates down through the soil. If arsenic is released into the atmosphere by industrial processes or volcanic activity, it attaches to particles that are dispersed by the wind and fall back to the ground. Microbes in soil and sediment also release substances containing arsenic into the atmosphere. These are then converted to other arsenic compounds that settle back onto the ground.

3. What are the levels of exposure to arsenic?

3.1 Environmental levels of arsenic vary. In air, levels are lowest in remote and rural areas, higher in urban areas, and highest close to industrial sources. In water, levels of arsenic are lowest in seawater, higher in rivers and lakes and highest in water from underground areas containing volcanic rock or arsenic-rich mineral deposits. The background levels of arsenic in soil and sediment increase if there are natural and/or man-made sources of arsenic contamination present.

3.2 The amounts of arsenic found in living animals, plants and microbes vary. The quantities depend on the level of local contamination and on the type of organism, as certain organisms tend to accumulate arsenic in their bodies. Arsenic is generally present in sea-living animals at higher levels than in freshwater animals, or plants and animals that live on land. Plants on land can accumulate arsenic compounds via uptake from soil and/or deposition from air onto leaves.

3.3 Humans are exposed mainly through food and water. Food is usually the largest source except in areas where drinking water is naturally contaminated with arsenic. The quantities of arsenic breathed in by non-smokers are very small, except in industrially polluted areas. Smokers inhale more because arsenic is one of many hundreds of chemicals present in

cigarette smoke. Exposure to arsenic in the workplace can be quite high, but the amounts present in the air in the workplace are controlled in many countries.

4. What happens to arsenic in the body?

4.1 When arsenic is inhaled due to its presence in airborne particles, the amount absorbed into the blood stream depends on two things – how soluble the particular form of arsenic is and how small the particles are. This said, most arsenic in the body comes from the diet. In the gut, soluble arsenic compounds present in food are rapidly absorbed into the blood stream. Many arsenic compounds are quickly transformed and eliminated from the body via the urine. However, there are differences from one person to another in the ability to get rid of arsenic compounds.

4.2 The amount of arsenic in the body can be estimated by taking samples of blood, urine, hair, or nails and measuring the arsenic - or arsenic-containing substances - present. Arsenic disappears rapidly from blood, so measurements in blood only tell you about recent high exposures, such as poisonings, or long-term exposures if they are repeated and high. Levels in urine are the best measure of recent exposure, whereas levels in hair and nails can tell you about past exposure.

5. What are the effects of arsenic on laboratory animals?

Arsenic can have adverse effects on laboratory animals but some forms of arsenic are more toxic than others. The consequences include death when exposures are high enough to cause poisoning and cancer. Many parts of the body may also be damaged by arsenic, including the skin, gut, lungs, heart, blood vessels, immune system, urinary system, reproductive organs and the nervous system. Arsenic can also damage chromosomes, which contain the genetic material inside the cells of the body.

6. What are the effects of arsenic on the environment?

Living organisms, both on land and in water, react in a variety of ways to arsenic exposure. The effects depend on the chemical form of the arsenic, the nature of the surrounding environment and their own particular biological sensitivity. Individual organisms or whole populations may be affected. Adverse effects include death, poor growth and failure to reproduce. Where arsenic has contaminated a natural environment, the number of different species found is much reduced.

7. What are the effects of arsenic on human health?

7.1 If a large amount of arsenic is swallowed by humans, in a form that is readily absorbed, it can cause rapid poisoning and death. The gut, the heart and the nervous system are affected. Those who survive acute poisoning may develop pigment spots in the skin and damage to red blood cells, bone marrow (where blood cells are made), liver, nerves and brain. Long-term exposure to high levels of arsenic in drinking water can cause thickening and pigment spots in the skin, and cancer of the skin, lungs, bladder or kidney. Exposure in the workplace – mainly via the air breathed in – can cause lung cancer. Smoking further increases the risk.

7.2 Long-term ingestion of arsenic, mainly from drinking of contaminated well water, has caused a disease called "blackfoot disease" in Taiwan. Blood vessels of the leg and foot become damaged, resulting in coldness, loss of feeling and eventually gangrene in the foot.

8. What has happened in areas where drinking water is heavily contaminated?

Drinking water from unpolluted sources normally contains only small amounts of arsenic. Drinking water from underground wells can become heavily contaminated in certain areas where the groundwater is in contact with natural arsenic from minerals. This can be a serious problem in countries like Bangladesh, West Bengal in India, and Taiwan. In Bangladesh, large numbers of people are regularly drinking water containing more than 5 times and up to more than 100 times the usual concentration of arsenic. Adverse effects on health, such as skin changes and cancer have been experienced by people living in these regions.

9. What have WHO and IARC established about arsenic?

International bodies have previously evaluated arsenic: the World Health Organization (WHO) has set a provisional guideline value of 10 µg/litre for arsenic in drinking-water and according to the International Agency for Research on Cancer (IARC) there is enough evidence to conclude that "arsenic and arsenic compounds" can cause cancer in humans.

10. Conclusions

Arsenic is a chemical substance, which is released from the Earth's crust via natural processes and from certain human activities. It can exist in inorganic or organic form, inorganic arsenic being generally considered more toxic. (see 1. and 2.)

Environmental levels of arsenic vary. Concentrations of the generally more toxic inorganic arsenic are highest in air close to industrial sources, in underground water in areas with natural geological contamination, and in soils or sediments near contamination sources. Concentrations of the less toxic organic arsenic are particularly high in sea-living animals and therefore in seafood.

Humans are exposed mainly through food and water, but arsenic can also be inhaled. After absorption into the blood stream, arsenic is rapidly transformed and eliminated from the body via urine. (see 3. and 4.)

Organisms living in the environment react in a variety of ways to arsenic exposure. It can even lead to death, poor growth and failure to reproduce. Where arsenic has contaminated a natural environment, the number of different species found is reduced. (see 5. and 6.)

In **humans**, if a large amount of the more toxic inorganic arsenic is swallowed in a form that is readily absorbed, it can affect the gut, the heart and the nervous system, causing rapid poisoning and death. Drinking water from unpolluted sources normally contains only small amounts of arsenic. However, in areas with natural geological contamination, such as Bangladesh, drinking water from wells can contain high levels of inorganic arsenic; such levels can harm the skin and are associated with increased risk of cancer in the skin, lungs, bladder and kidney. Exposure to contaminated air at the workplace can cause lung cancer. (see 7. and 8.)

Arsenic and arsenic compounds have been classified as carcinogenic to humans and guideline values for drinking-water have been set. (see 9.)