

## History of Arsenic in Dentistry

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### Abstract

Arsenic has been a widely used dental material mostly for emergency to necrotize the inflamed pulp before root canal. Due to its toxic side effects is no longer in use.

**Keywords:** mineral, restorative material, toxic, mutagenic, root canal

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Arsenic occurs naturally in the Earth's crust at a concentration of less than 0.0002%. It appears as both an anion and cation in many minerals, most commonly in combination with sulfur. Its most significant mineral form is arsenopyrite. Although arsenic can also be found in independent deposits—especially in association with mercury or antimony—most of the world's arsenic production is obtained as a by-product of mining operations for gold, copper, zinc, lead, and cobalt.

Arsenic and its compounds are highly toxic, cytotoxic, carcinogenic, and mutagenic. In nature, it occurs in various forms, though its compounds are more common. These include red realgar or arsenic disulfide ( $As_2S_2$ ), yellow orpiment or arsenic trisulfide ( $As_2S_3$ ), and arsenic trioxide and diarsenic pentoxide ( $As_2O_3$ ,  $As_2O_5$ ). Arsenic often occurs in ores containing sulfur and metals. It is frequently mixed with antimony, and may contain traces of gold, silver, and iron, especially in arsenic-containing silver ores.

Arsenic is a gray, metallic, brittle element that crystallizes in a hexagonal system and has a specific gravity of 5.73. (Fig 1.) It does not melt when heated but sublimates directly into vapor. It can, however, be melted in a sealed container under high-pressure air. The vapor is lemon-yellow in color and has a strong garlic-like odor.<sup>1</sup>

### A Discreet but Effective Poison

Humans can gradually develop tolerance to many poisons, a process known as mithridatism, named after Mithridates VI (120–63 B.C.E.), ruler of the Kingdom of Pontus (in Northern Anatolia). Constantly fearing assassination by poisoning, Mithridates began ingesting small doses of various poisons to build

resistance. He eventually created a complex antidote composed of 54 ingredients, which he named mithridaticum.

In large doses, arsenic is lethal within 1–2 hours. In smaller doses, it kills more slowly. Symptoms of chronic arsenic poisoning include a scratching sensation in the throat, burning stomach pain, vomiting, enteritis, diarrhea, muscle cramps, and intense thirst due to dehydration.

Throughout history, poison was widely used for both crime and punishment. In ancient Egypt, known poisons included hydrocyanic acid, lead salts, antimony, copper salts, opium, entrails, and castor oil. In ancient Athens, hemlock decoction was the official execution poison, most famously used in the death of Socrates. In Imperial Rome, arsenic became known as the "sinful poison" and was so frequently used that in 83 B.C., the *lex Cornelia de sicariis et veneficis* was passed, criminalizing poisoning.

The Christian world was not exempt. Poison was often used to inherit wealth or eliminate political enemies. By the mid-13th century, people were aware of the dangers of rotting organic matter such as eggs, fish, and meat. Arsenic was the most favored poison. In 15th-century Italy, chroniclers documented the horrors perpetrated by Pope Alexander VI and Cesare Borgia, both of whom also fell victim to poison. Entire banquet parties were poisoned in events like the tragedy involving Lucrezia Borgia. Among the most infamous poisoners was Julia Toffana, who reportedly killed over 600 people using her deadly Aqua Toffana (Fig 2.) or *acquetta di Napoli*, said to be derived from the putrefactive saliva of arsenic-poisoned animals.<sup>2</sup>

In the 17th century, sublimate (mercuric chloride) became commonly used in Venice and Amsterdam. In France, arsenic, sublimate, and sometimes opium were utilized.

### **Arsenic in Dental Treatment**

During the Middle Ages, Arab physicians such as Rhazes, Albucasis, and Avicenna (drawing from Galen) used arsenic with enthusiasm to relieve toothaches. In 1529, Scribonius Largus used a heated metal needle to cauterize and destroy dental nerves. Supporting chemicals included ammonium, sulfuric acid, lapis, and various forms of arsenic.<sup>3</sup>

Arsenic's first documented use in modern dentistry occurred in 1836, when John Roach Spooner recommended it as a method for root canal treatment.<sup>4</sup> Over the years, several forms of arsenic were adopted:

- Willoughby Miller introduced metallic arsenic (with cobalt) in 1880.
- Dickinson advised leaving arsenic in the cavity for 15–18 hours.
- In 1875, Langsdorf applied it directly to the pulp, limiting exposure to 6–7 hours to kill the nerve painlessly.
- Braun in 1917 used arsenic exclusively for molars.

- In 1920, Moginier histologically examined cobalt-induced damage, observing crusting and tissue necrosis.

Arsenic acid (H<sub>3</sub>AsO<sub>4</sub>) became widely used. According to Euler (1920), dental pulp necrosis occurred through both direct and indirect effects. Many practitioners developed unique combinations to optimize the treatment. In 1887, Trumann combined arsenic acid with 5% carbonic acid. That same year, Kirk used a mixture containing arsenic acid, cocaine hydrochloride, menthol crystals, and glycerine. Witzel used morphine, phenol, arsenic, and mercury chloride. Some dentists applied pure arsenous acid.

In 1902, Hungarian endodontics pioneer Szabó introduced pulp lavage to minimize bleeding before applying arsenous acid, making the process painless.

In the 1920s, arsenic pastes became part of a practice known as "theatre root canal treatment". If a patient with acute pulpitis appeared just before the dentist had theatre plans, a quick application of arsenic would relieve pain in minutes, allowing the dentist to proceed with leisure.

However, arsenic had severe side effects, including the risk of bone necrosis. By the 1940s, arsenic was gradually removed from dental emergency treatment protocols.

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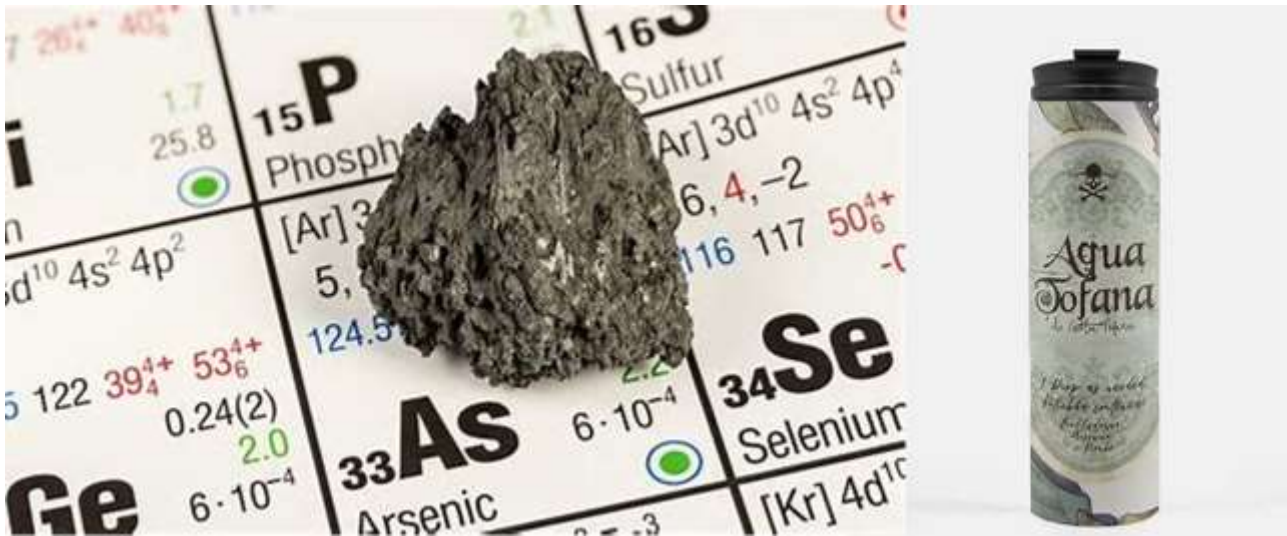


Fig. 1. Arsenic ore and its place in the periodic table.

Fig 2. Aqua Toffana