

Nitrates and Nitrites

Answers to Frequently Asked Health Questions

What are Nitrates/Nitrites?

Nitrates and nitrites are chemicals that can be found naturally in our environment. Two of earth's most common elements, nitrogen and oxygen, combine to form these nitrogen-containing compounds. Nitrates are essential (needed) nutrients for plants to grow. Nitrates can be found in the air, soils, surface waters and groundwater (underground drinking water).

How are Nitrates used?

Because nitrates are needed for plants to grow, concentrated man-made nitrogen-containing fertilizers are used on golf courses, lawns and are heavily used in farming communities to grow vegetable crops. Nitrates and nitrites are also used as meat preservatives and to improve the color of meats.

How do Nitrates get into the environment?

Nitrates are generally found in surface waters and shallow groundwater. Plants naturally release nitrogen when they die and decompose (rot). The nitrogen from the rotting plants oxidize (combine with oxygen) to form nitrates. During a rainfall, surface water can move through the soil and carry these nitrates down to the underground drinking water (groundwater).

Other ways water can be contaminated with nitrates is through the use of products that contain large amounts of ammonia. Ammonia is oxidized (combines with oxygen) and forms nitrites. Liquid ammonia fertilizer spills can form nitrates that also make their way through the soil to the ground water.

Because humans and animals (mammals) eat vegetables and preserved meats, nitrates and nitrites can be found in human and animal waste. Old and poorly maintained sewage systems and improper well construction can contaminate ground water with nitrates as well.

How can I be exposed to Nitrates?

The main exposure route to nitrates is by eating vegetables and preserved meats. Vegetables account for more than 70% of the nitrates in a typical human diet. Cauliflower, collard greens, broccoli, spinach and root vegetables (potatoes, beets, turnips, etc.) contain higher amounts of nitrates than other plant foods. About 6% of the exposure comes from meat and meat products; which sodium nitrate is used as a preservative and color-enhancing agent.

The remainder of the nitrate in a typical diet comes from drinking nitrate-contaminated water (about 21%). In agricultural (farming) areas, nitrates are a source of contamination of lakes, reservoirs, and rivers, and also for shallow groundwater aquifers that provide drinking water.

Can exposure to Nitrates/Nitrites make me sick?

Yes, exposure to nitrates and nitrites can make you sick. However, getting sick from exposure to nitrates/nitrites will depend on many factors such as:

- The route of exposure (eating or drinking)
- How much you were exposed to (dose).
- How long you were exposed (duration).
- How often you were exposed (frequency).
- General Health, Age, Lifestyle Young children, the elderly and people with chronic (on-going) health problems are more at risk to chemical exposure

What other factors can affect a person's health risk to Nitrate/Nitrite exposure?

- Age and weight
- Diets low in vitamin C
- People with reduced stomach acidity, such as those being treated for ulcers
- Gastroenteritis, an inflammation of the stomach and intestines (gut)
- Diets high in preserved meats such as bacon or sausage
- Cancer patients with compromised hemoglobin
- Smoking, drinking alcohol or taking certain medicines or drugs
- Past chemical exposures.

What happens to Nitrates/Nitrites in my body?

Exposure to nitrates and nitrites are not usually an immediate (acute) health threat. When you eat or drink nitrates, they are absorbed from the small intestine (gut) into the blood. Nitrates then enter the large intestine from the blood. If certain, normal conditions exist in the intestine, such as a low pH, the nitrate is simply processed and removed as waste without any harmful effects.

However, under other conditions, such as a high pH in the intestine, the nitrate will be changed into nitrite. This nitrite is then reabsorbed into the blood where it will react with the blood's hemoglobin iron to form methemoglobin.

Note: The hemoglobin in our blood carries (transports) oxygen throughout our body.

The condition where the nitrite reacts with the iron and hemoglobin is known as methemoglobinemia (often called "blue baby syndrome"). Unlike hemoglobin that carries oxygen throughout our body, methemoglobin is unable to transport oxygen. A person who has methemoglobinemia can lack the proper oxygen levels needed for the body to function correctly. One of the signs of methemoglobinemia is cyanosis (turning a blue color).

Who is at risk to Nitrate/Nitrite exposure?

The persons most at risk to exposure to nitrates/nitrites are infants less than six-months old who are fed formula made with nitrate-contaminated water at levels above the U.S. Environmental Protection Agency's (EPA) safe drinking water standards of 10ppm (10 parts per million). **Note: "ppm" is a unit of measurement. An example of 10 parts per million would be having ten beans in a pile of one million beans.**

Infants are more sensitive to nitrates because they take in more water for their body weight. Also, infants' blood contains a form of hemoglobin, fetal hemoglobin, which is more easily changed into methemoglobin than is adults' hemoglobin. In addition, infants' digestive systems have a higher pH, which increase the changing of nitrates into nitrites.

Infants exposed to nitrates above the safe drinking water levels may experience breathing difficulties, have a decrease/drop in blood pressure (hypotension), less than average weight gain and may fail to meet developmental milestones.

Pregnant women may be more sensitive to nitrates because their blood contains higher levels of methemoglobin. They may be especially sensitive at the 30th week of pregnancy or later.

Short-term exposure:

Short-term exposure to high levels of nitrates can cause nausea (upset stomach), diarrhea, vomiting, dizziness, blurred vision, breathing problems and eventually muscle paralysis. Symptoms usually develop 18–36 hours after the high levels of nitrates are consumed, but they can occur as soon as two-hours or as long as 14 days later.

Signs and symptoms of methemoglobinemia:

Below is the percentage (%) of methemoglobin found in the blood and the health problems expected.

10-20%	Cyanosis (turning blue) of limbs/trunk; usually asymptomatic (meaning without other medical problems seen)
20-45%	Nervous system problems such as headache and dizziness
45-55%	Shock, convulsions, arrhythmias (irregular heart rate) and coma
Over 70%	High risk of mortality (death)

* Except in infants, methemoglobinemia is generally not fatal and can be treated without lasting effects.

Is there a treatment for Nitrate exposure?

People with blood methemoglobin levels less than 20%, with no symptoms, do not require treatment. People having moderate to severe symptoms should receive 100% oxygen immediately. Other therapies for severe symptoms include receiving intravenous (IV) of methylene blue and a blood transfusion.

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Do Nitrates/Nitrites cause cancer?

Studies have shown that exposure to nitrates can cause cancer in lab animals. Nitrates, when used as preservatives and color-enhancing agents for meats, can react with the body's natural amino acids to form nitrosamines. Nitrosamines have been linked with cancers in humans.

There have been studies in farming communities that have found increased rates of colon and bladder cancers. But exposures to pesticides (bug killers) and diets high in preserved meats can increase the risk of cancer in these populations. Currently there is no solid evidence that nitrates in drinking water causes cancer in people.

Is there a test to find out if I have been exposed to Nitrates/Nitrites?

There are several tests which measure exposure to nitrates/nitrites. Most commonly, a drop of the exposed person's blood is placed on a piece of filter paper beside a drop of blood from an unexposed person. When dry, the exposed person's blood containing methemoglobin will be deep chocolate brown or slate grey in comparison to the red blood from an unexposed person. Also, a tube of methemoglobin-containing blood will not turn red when shaken in the air.

What levels of Nitrates/Nitrites are safe?

The U.S. EPA MCL (maximum contaminate level) requires the amount of nitrates in drinking water be less than 10 ppm (parts per million). The public drinking water supplies are tested quarterly and the water is treated to remove impurities. Ohio Administrative Code (OAC) Chapter 3701-28-04 established a nitrate standard for private water systems in Ohio of 10 ppm. All new and altered wells are pre-screened and tested for the presence of nitrates (since 2000). Your local health district can assist with nitrate testing.

How can I reduce my intake of Nitrates/Nitrites?

Keep in mind that healthy vegetables are the main source of nitrates, but vegetables are good for you and we would never suggest removing vegetables from your diet.

However, you can reduce your intake of nitrates by:

- Reducing the amount of preserved meats you eat (such as sausage, bacon, hot dogs, etc.).
- If your public water system has a nitrate advisory posted, use an alternate approved source of water for drinking and food preparation or cooking.
- If you drink well water, make sure you are drinking water that is not contaminated with nitrates.
- Infant formula should be made with an alternative approved source when the nitrates are higher than 10 ppm.
- Vitamin C will help prevent the nitrates changing to nitrites. Diets high in vitamin C will reduce the risk of methemoglobinemia.

References

- Agency for Toxic Substances and Disease Registry, Nitrate/Nitrite Toxicity, September, 2015.
- Toxics A to Z, University of California Press, 1991.
- Handbook of Toxic and Hazardous Chemicals and Carcinogens, 2nd edition, Noyes Publications, 1985.