Nitrate in Drinking Water

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Drinking water high in nitrate is potentially harmful to human and animal health. Nitrate (NO₃) is a naturally occurring form of nitrogen (N) which is very mobile in water. It is essential for plant growth and is often added to soil to improve productivity. Water moving down through soil after rainfall or irrigation carries dissolved nitrate with it to ground water. In this way, nitrate enters the water supplies of many homeowners who use wells or springs. It is estimated that about three percent of residential wells in North Carolina contain nitrate at levels exceeding the safe drinking water standard.

Health Concerns

Infants under six months of age are susceptible to nitrate poisoning. Bacteria that live in the digestive tracts of newborn babies convert nitrate to nitrite (NO₂). Nitrite then reacts with hemoglobin, which carries oxygen in blood, to form methemoglobin. Methemoglobin cannot carry oxygen, thus the affected baby suffers oxygen deficiency. The resulting condition is referred to as methemoglobinemia, commonly called "blue baby syndrome."

The most noticeable symptom of nitrate poisoning is a bluish skin coloring, called cyanosis, particularly around the eyes and mouth. A baby with bluish skin should be taken to a medical facility immediately and tested for nitrate poisoning. The blood sample of an affected baby is chocolate brown instead of the normal bright red due to lack of hemoglobin. Methemoglobinemia is relatively simple to treat, and in most reported cases, the affected baby makes a full recovery.
Within several months after birth, the increasing level of hydrochloric acid in a baby's stomach kills most of the bacteria which convert nitrate to nitrite. By the age of six months, the digestive system is fully developed, and the risk of nitrate-induced methemoglobinemia is greatly reduced.

Water quality standards for human consumption have been set at ten milligrams of nitrate-nitrogen per liter of water (10 mg/L NO3-N). This level of nitrate-nitrogen is equivalent to 45 mg/L of nitrate (NO3). When reading water quality laboratory reports, be sure to note whether reported values are for nitrate-nitrogen or nitrate. Note that one mg/L equals one ppm (part per million). Most reported cases of blue baby syndrome due to contaminated water have occurred when infant formula was prepared using water with greater than 40 mg/L NO3-N.

Consumption of high-nitrate water by pregnant women and nursing mothers is not as likely to be harmful to babies as direct consumption. The health effects in these cases are not completely understood, so it is recommended that pregnant women and nursing mothers limit nitrate consumption. Possible connections between nitrate and other health problems such as nervous system disorders, cancer, and heart damage are not well documented and are currently being researched.

Ruminant animals (cattle and sheep) and infant monogastrics (baby pigs and baby chickens) are also susceptible to nitrate poisoning because of bacteria living in their digestive tracts. Horses, even though they are monogastric, are susceptible to nitrate poisoning throughout their lives. Livestock may be exposed to large quantities of nitrate in their feed as well as in contaminated water. Animals which are treated in time can recover fully from nitrate poisoning. Scientific studies indicate that water with greater than 25 mg/L NO3-N can be harmful to animals.

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**Treatment Options**

Because nitrate is tasteless and odorless, water must be chemically tested to determine contamination. Your County Health Department and many private laboratories will test for nitrate. County Extension offices have lists of certified private laboratories in North Carolina which test for nitrate. Before investing in treatment equipment or a new water supply, have your water tested at a reputable laboratory.

If your water contains greater than 10 mg/L NO3-N, your options for reducing health risks are substitution, in-home treatment, and source elimination. Substitution of bottled water for drinking and cooking is a simple and relatively inexpensive means of reducing nitrate intake.

Nitrate is easily dissolved in water, which means that it is difficult to remove. Three water treatment systems that remove nitrate are **distillation**, **reverse osmosis**, and **ion exchange**.

- Distillation boils water, then catches and condenses the steam while nitrate and other minerals remain in the boiling tank.
- Reverse osmosis forces water under pressure through a membrane to filter out contaminants.
• Ion exchange introduces another substance, normally chloride, to "trade places" with nitrate in water.

Treatment of drinking water to remove nitrate is expensive. Consider not only the initial purchase price but also the cost of regular maintenance when purchasing a water treatment system.

Simple household treatment procedures such as boiling, filtration, disinfection, and water softening do not remove nitrate from water. Boiling actually increases the nitrate concentration of the remaining water.

The source of nitrate contamination should be identified and eliminated whenever possible. Potential sources of nitrate include septic systems, animal waste, commercial fertilizer, and decaying organic matter. Surface water which comes in contact with a source of nitrate and then moves downward through soil will carry nitrate to groundwater. Shallow wells are susceptible to nitrate contamination because there is less soil and rock to serve as a filter between the soil surface and the ground water supply. Nitrate contamination levels may vary with time of year depending on the source of the pollutant.

Ideally, drinking water supplies (wells or springs) should be up hill and at least 100 feet away from all possible sources of contamination. Remember that any fertilizers or organic materials which are placed near a well are potential contamination sources for your water. It takes only a very small quantity of nitrate entering your water supply to raise the concentration to an unsafe level.

Several measures may be taken to protect your well from direct contamination by surface water. Earth berms should be built to divert surface runoff away from the wellhead. The well casing should extend above ground. If the casing was cut off below ground, an extension may be welded onto the top of the existing casing. Proper well protection also includes grouting around the outside of the well casing and placing a concrete slab around the wellhead. Contact your County Extension Office or County Health Department for more information on well protection, water quality testing, and water treatment systems.

See Basic Information about Nitrate in Drinking Water

See EPA's private drinking water wells Web site