What Is Nitrate?

Nitrate is an inorganic compound that occurs under a variety of conditions in the environment, both naturally and synthetically. Nitrate is composed of one atom of nitrogen (N) and three atoms of oxygen (O); the chemical symbol for nitrate is NO3. Nitrite (NO2) can be formed from nitrate by a chemical process called reduction. Nitrate does not normally cause health problems unless it is reduced to nitrite.

Nitrate in drinking water is measured either in terms of the amount of nitrogen present or in terms of both nitrogen and oxygen. The federal standard for nitrate in drinking water is 10 milligrams per liter (10 mg/l) nitrate-N, or 45 mg/l nitrate-NO3. when the oxygen is measured as well as the nitrogen. Unless otherwise specified, nitrate levels usually refer only to the amount of nitrogen present, and the usual standard, therefore, is 10 mg/l.

Short-term exposure to drinking water with a nitrate level at or just above the health standard of 10 mg/l nitrate-N is a potential health problem primarily for infants. Babies consume large quantities of water relative to their body weight, especially if water is used to mix powdered or concentrated formulas or juices. Also, their immature digestive systems are more likely than adult digestive tracts to allow the reduction of nitrate to nitrite. In particular, the presence of nitrite in the digestive tract of newborns can lead to a disease called methemoglobinemia.

Infant Feeding Practices to Minimize Intake of Nitrate and Nitrite

1. Breast feeding. Little if any nitrate gets into breast milk, unless the mother is consuming very large quantities of nitrate. Also, bacterial contamination is not a problem when breast milk is consumed directly.

2. Bottle feeding. Use already diluted liquid formulas or use low-nitrate water to dilute concentrated liquid or powdered formulas. Also, mixed formulas should be kept under refrigeration and used promptly to minimize bacterial reduction of nitrate to nitrite.

3. Vegetables. Since many vegetables are high in nitrate, their consumption should be limited until an infant is 4-6 months old and their digestive tract has sufficiently matured. Your physician can help you decide when to add new foods. Vegetables should always be prepared while fresh and refrigerated promptly after cooking to minimize bacterial activity

What Is Methemoglobinemia?

Methemoglobinemia is the most significant health problem associated with nitrate in drinking water. Blood contains an iron-based compound called hemoglobin, which carries oxygen. When nitrite is present, hemoglobin can be converted to methemoglobin, which cannot carry oxygen. In the blood of adults, enzymes continually convert methemoglobin back to hemoglobin, and methemoglobin levels normally do not exceed 1 percent. Newborn infants have lower levels of these enzymes, and their methemoglobin level is usually 1 to 2 percent. Anything above that level is considered methemoglobinemia.

Few clearcut symptoms are associated with methemoglobin levels between 1 and 10 percent. At higher levels, symptoms of cyanosis usually appear. Babies with this condition have bluish mucous membranes and may also have digestive and respiratory problems. At methemoglobin levels above 20 to 30 percent, the primary effects result from the blood's severely reduced oxygen-carrying capacity and are referred to as anoxia. At methemoglobin levels around 50 to 70 percent, brain damage or death can occur.

Once diagnosed, methemoglobinemia can be readily reversed, although with anoxia permanent damage may have occurred. Methemoglobinemia can be prevented by restricting consumption of nitrite and nitrate and by limiting the opportunities bacteria have to reduce nitrate in food to nitrite before consumption.

Consuming drinking water with nitrate levels near the drinking water standard does not normally increase the methemoglobin level of humans beyond infancy. Some individuals, however, may have increased susceptibility to methemoglobinemia due to exposure to antioxidant medications and chemicals, or other conditions that may inhibit the body's ability to reconvert methemoglobin to hemoglobin (such as pregnancy or certain rare diseases).

Nitrate in drinking water starts affecting the health of the general populace at levels in the range of 100 to 200 mg/l nitrate-N, but the effect on any given person depends on many factors, including other sources of nitrate and nitrite in the diet. Some of the nitrate consumed can be converted in the body to nitrite, which under appropriate circumstances can combine with amines (portions of protein molecules often found in foods, medications, cigarette smoke, decaying plants, soil, and sometimes water) to form nitrosamines, well-documented cancer-causing substances. So far, the only studies linking nitrate in drinking water with cancer have involved nitrate levels that are quite high (at or above 100-200 mg/l nitrate-N).