NebGuide

University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources

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Drinking Water: Fluoride

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University of Nebraska–Lincoln Extension and the Nebraska Department of Health and Human Services place a high priority on water quality and jointly sponsor this series of educational publications.

At optimal levels, fluoride in drinking water can be beneficial to dental health. Learn more about fluoride concentration and potential health effects through this publication.

Sources of Fluoride in Drinking Water

Fluoride, a naturally occurring element, exists in combination with other elements as a fluoride compound and is found as a constituent of minerals in rocks and soil. When water passes through and over soil and rock formations containing fluoride it dissolves these compounds, resulting in the small amounts of soluble fluoride present in virtually all water sources.

A study of naturally occurring fluoride in Nebraska's groundwater reported a range of concentrations from less than 0.1 milligrams per liter (mg/l) to 2.6 mg/l with an average of 0.3 mg/l (Headrick, 1996). According to the study, three areas in Nebraska — the Upper Republican River Valley, Knox County, and the Panhandle — had average concentrations higher than 0.6 mg/l or had average concentrations near 0.6 mg/l with a significant percent of samples over 1.5 mg/l. According to a Nebraska Department of Health and Human Services (DHHS) database and a U.S. Geological Survey database used in the Headrick study, counties included in the three areas were: Chase, Dundy, Hayes, Hitchcock, Red Willow, Frontier, Knox, Box Butte, Kimball, Cheyenne, and Scotts Bluff. (*Figure 1*).

In addition to naturally occurring fluoride, some communities add fluoride to the public water supply, a process known as fluoridation.

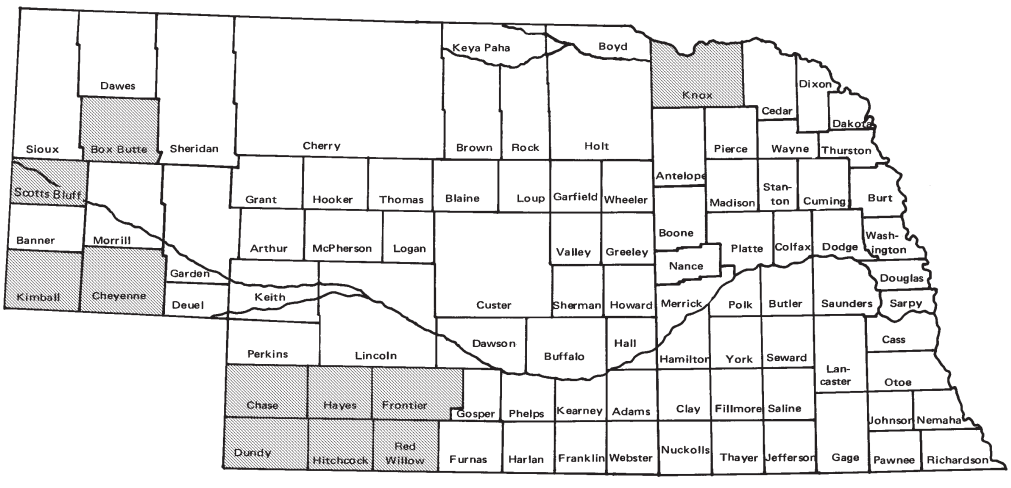

Figure 1. Counties with average groundwater fluoride concentrations (milligrams per liter) greater than 0.5 mg/l.

Indications of Fluoride

Fluoride in drinking water cannot be detected by taste, sight, or smell. Chemical testing is the only way to determine the fluoride concentration.

Potential Health Effects

As with many substances, potential health effects are directly related to the concentration present. The U.S. Department of Health and Human Services (HHS), Centers for Disease Control and Prevention, and the American Dental Association recommend an **optimum level** of 0.7 mg/l to ensure potential benefits while minimizing or eliminating potential risks. Fluoride levels in drinking water are discussed in the "Interpreting Test Results" section.

The dental benefits from consuming water containing optimum levels of fluoride are well-documented. Since the 1930s, many scientific studies have shown that water fluoridation, at the optimum concentrations recommended for good dental health, has no known harmful effects.

Fluoridation is endorsed by the Centers for Disease Control and Prevention, American Dental Association, and the American Medical Association, as well as numerous national and international health organizations. Additional sources of fluoride include foods, beverages, and many oral care products, such as toothpastes, mouth rinses, and gels. Topical treatment and supplements are available from physicians and dentists. All potential sources of fluoride should be considered when developing a dental care plan.

Information and recommendations are available in numerous expert panel reports such as those listed on page 4. At optimum levels, fluoride protects against tooth decay. The American Dental Association has stated that fluoride benefits people of all ages. When children are young and their teeth are forming, fluoride makes tooth enamel harder and more resistant to decay-causing acid. Studies indicate that people who drink optimally fluoridated water from birth will experience up to 40 percent less decay over their lifetimes. For adults, fluoride helps repair the early stages of tooth decay even before it becomes visible, a process known as remineralization. For older adults, fluoride can decrease problems with root caries (decay along the gumline).

Although low levels of fluoride are beneficial, excessive amounts can be harmful. Fluoride in drinking water above optimum levels may produce fluorosis (mottling of teeth). Dental fluorosis appears during tooth formation. The effects can be mild to severe, ranging from barely perceptible white striations or specks on teeth, to permanent brown to brownish gray stains on teeth and/or severe pitting. The National Research Council (NRC) conducted a scientific review of research on various health effects, including dental effects, from consuming water with fluoride at the maximum level allowed in public water supplies (over four times greater than the recommended optimum level.) They reaffirmed that continued consumption of water containing increasingly higher concentrations of fluoride above optimum levels will generally produce more severe dental fluorosis. While the effect of mild to moderate fluorosis is believed to be cosmetic only, 10 of the 12 committee members concluded that enamel loss and pitting associated with severe fluorosis may increase the risk of tooth decay and infection. Like other trace elements, excessive quantities of fluoride can result in acute toxicity. Consuming an excessive amount of fluoride (300 to 750 milligrams depending on body weight) in a single dose can result in nausea or vomiting. This level of fluoride intake could occur as a result of some type of accidental event, such as small children consuming an overdose of fluoride supplements. At the optimum fluoridation level of 0.7 mg/l, an individual would need to ingest 80 to 200 gallons of water in a few hours to reach the acute toxicity level, an amount impossible to drink in that time period.

The possibility of chronic health effects from continuous consumption of drinking water with fluoride above optimum levels has also been studied. The NRC scientific review included research on possible musculoskeletal, reproductive and developmental, neurotoxicity and neurobehavioral, endocrine, and carcinogenicity effects from exposure to fluoride in drinking water at the maximum level allowed in public water supplies (over four times greater than the recommended optimum level.) The committee concluded that scientific evidence suggested adverse effects were unlikely, or that evidence is tentative and mixed, for adverse health effects studied, with the exception of bone health. While the report's authoring committee was not in total agreement, the majority concluded that chronic health effects included a likely increase for bone fractures, particularly in those prone to accumulate fluoride into their bones. The EPA and CDC currently state on their websites that some people who drink water containing fluoride in excess of the maximum level allowed over many years could be more prone to bone fractures or bone disease (including pain and tenderness of the bones.) **This publication does not substitute for professional medical advice. If you have any questions or concerns related to potential health effects from consuming fluoridated water, consult your physician.**

Testing

Testing Public Water Supplies

The quality of water supplied by public water systems is regulated by EPA under the federal Safe Drinking Water Act. The Nebraska DHHS is responsible for implementing and enforcing Safe Drinking Water Act standards in Nebraska. Under these regulations, public water supplies must be tested for fluoride concentration. To find out the fluoride level from a public water supply, contact your water supplier.

Testing Private Water Supplies

Water quality in private wells is not currently regulated in Nebraska; thus, testing a private water supply is not required. All water sources contain some naturally occurring fluoride. If users want to know the concentration of naturally occurring fluoride in a private water supply, they will need to have the water tested at their own expense. The DHHS approves laboratories to conduct tests from drinking water samples. For information on laboratories approved to test for fluoride, contact:

Nebraska Department of Health and Human Services
Department of Regulation and Licensure
Public Health Laboratory
3701 South 14th
Lincoln, NE 68505
402-471-2122

Non-certified laboratories may use the same equipment and procedures as a certified laboratory. Such laboratories may provide accurate analyses, but there is no independent information about the laboratory's ability to obtain reliable results.

Interpreting Test Results

Public Water Supply Test Results

Fluoride guidelines for dental health benefits were established by the U.S. (HHS) in the 1960s. The recommended level of fluoride in drinking water for dental benefits was set at 0.7 to 1.2 mg/l. The guideline was revised to replace the range with a proposed recommended concentration of 0.7 mg/l. Under the Safe Drinking Water Act, the EPA is required to regulate the quality of water supplied by public water systems. EPA standards restrict the total amount of a substance allowed in drinking water, and are designed to prevent undesirable effects that could result from exposure to a substance at concentrations above those allowed. Drinking water standards fall into two categories: Secondary Standards and Primary Standards. Secondary Standards are based on aesthetic factors such as taste, odor, color, corrosivity, foaming, and staining properties of water that may affect water's

suitability for drinking and other domestic uses. Primary Standards are based on health considerations and are designed to protect human health. EPA established a recommended Secondary Standard and an enforceable Primary Standard for fluoride in 1986. **The Nebraska DHHS enforces Safe Drinking Water Act guidelines in Nebraska's public water supplies.**

The Secondary Maximum Contaminant Level (SMCL) for fluoride is 2.0 mg/l which is equal to 2.0 parts per million (ppm). Water with a fluoride concentration at or below 2.0 mg/l does not present a health risk and should not cause appreciable fluorosis. Mild to moderate fluorosis is not considered a health risk but does have an aesthetic impact on teeth. See the Potential Health Effects Section for more information on fluorosis.

The Primary Maximum Contaminant Level (MCL) for fluoride in drinking water is 4.0 mg/l which is equal to 4.0 ppm. Daily consumption of water with a fluoride concentration at 4.0 mg/l was believed to not present a health risk based on best available science at the time of the MCL enactment. The National Research Council Report (2006) concluded that exposure at the current MCL puts children at risk for developing severe fluorosis that may compromise tooth function, and could put adults at increased risk of bone disease, especially in those prone to accumulate fluoride into their bones. It is important to note that the allowable MCL is over four times the optimum concentration recommended by the U.S. HHS.

Nebraska statutes require all Nebraska public community water supplies serving populations over 1,000 to fluoridate at optimum levels unless citizens of the community opted out through a ballot vote. Fluoridation is not required for water supplies that have naturally occurring fluoride at optimum levels. The DHHS Department of Dental Health recommends a fluoride concentration of 0.7 to 1.5 mg/l to ensure potential benefits while minimizing or eliminating potential risks.

The following information related to naturally-occurring fluoride in public water supplies, or fluoridation of public water supplies is current as of publication date for this NebGuide, but could change with time. If a significant amount of time has passed since publication date, readers may want to verify correctness through their water supplier for a particular location.

As of March 2014, DHHS reported that Nebraska public water supplies with naturally occurring fluoride at or above 0.7 mg/l include:

Abie
Alliance
Benkelman
Big Springs
Broadwater
Bushnell
Ceresco
Chappell
Clarks
Craig
Culbertson
Dix
Gurley
Haigler
Hayes Center
Hemingford
Imperial
McCook
Oakland
Omaha Tribal Utilities
Oshkosh
Palisade
Ponca
Sarpy Co. SID #158 - Tiburon
Stockville
Stratton
Trenton
Uehling
Verdel
Walthill
Wauneta
Winnebago

As of March 2014, DHHS reported that the following Nebraska public water systems fluoridate their water supply. Some Nebraska communities buy their water supply from a utility rather than operate their own water system. Communities that buy fluoridated water are indented and italicized and listed under the public water supply from which their water is obtained.

Adams
Albion
Allen
Alma
Arlington
Ashland
Atkinson
Auburn
Beatrice State - Developmental Center
Blair
Kennard
Shannon Estates
Washington Co. RWD #2
Country Estates MHP
Bloomfield
Blue Hill
Burwell
Cedar-Knox RWP
Crofton
Fordyce
St. Helena
Obert
Coleridge
Belden
Columbus
Cook
Creighton
Elgin
Emerson
Fairbury
Little Blue NRD RWD #1
Falls City
Richardson County RWD #2
Salem
Verdon
Rulo
Fremont
Meadowbrook MHP
Fullerton
Gering
Gordon
Gibbon
Gretna
Hallam
Hartington
Hickman
Holdrege
Kearney
Laurel
Lincoln
Louisville
Lyons
Macy
Magnet
Metropolitan Utilities District
Bellevue
Bennington
Elkhorn
LaVista
Maplewood Estates MHP
Omaha
Papio-Missouri River NRD - Washington County
Fort Calhoun
Paradise Lakes
Ralston
Waterloo
Minden
Nebraska City
Otoe County RWD #1
Neligh
Nelson
North Bend
O'Neill
Ogallala
Osmond
Papillion
Pender
Papio-Missouri River NRD - Thurston Co.
Plattsmouth
Cass County SID #7 - Swallow Hills
Cass County RWD #1
Murray
Nehawka
Red Cloud
Rushville
Santee Tribal Utilities
Scribner
Seward
Shelby
South Sioux City
Springfield
Stella
Superior
Syracuse
Tecumseh
Johnson County RWD #1 East
Tilden
Utica
Valley
Valparaiso
Wausa
Waverly
Wayne
West Point

Private Water Supply Test Results

EPA and Nebraska regulations do not apply to private drinking water supplies. Thus, fluoride concentration in private drinking water is unregulated. It is highly unlikely that naturally occurring fluoride concentrations would occur above the concentration allowed in a public water supply. If naturally occurring fluoride concentrations are found to be above the optimum or desired level, users might voluntarily consider reducing the fluoride concentration.

Options

Options for Adding Fluoride to Public Water Supplies

To add fluoride to drinking water, a public water supply will need to add it at each point of entry to the water system. A point of entry is where the water from at least one well or treatment plant is connected to the distribution system. To add fluoride at entry points, chemical feed equipment and tanks, safety equipment, and modifications to the distribution system pipes will be required. If suitable space to house the feed equipment is unavailable near the point of entry, modifications to a building or a new building will be required.

Options for Adding Fluoride to Private Water Supplies

It is not practical to fluoridate private drinking water supplies. If the fluoride level is less than desired, bottled water may be a viable option. The U.S. Food and Drug Administration regulates bottled water and allows fluoride in bottled water either from naturally occurring sources or fluoridation. Therefore, some, but not all, bottled water may contain fluoride. Check the label or contact the manufacturer for information on fluoride concentration in the product selected. If the desired fluoride needs cannot be met through the drinking water source, it may be necessary to use fluoride supplements, generally obtained by prescription from a doctor/dentist.

Removing Fluoride at the Tap

If naturally occurring fluoride in public or private water supplies exceeds optimum levels, or if the presence of fluoride in public drinking water through fluoridation is undesirable, an alternative drinking water source or water treatment are viable options. An alternative water source for drinking and cooking may be obtained from bottled water. Since bottled water also may contain fluoride, check the label, or contact the manufacturer for information on the fluoride concentration in the product selected. Four treatment methods are suitable for removing fluoride from drinking water, including activated alumina filters, distillation, reverse osmosis, and anion exchange. For more information on reverse osmosis or distillation, see *Drinking Water Treatment: Reverse Osmosis* (G1490) and *Drinking Water Treatment: Distillation* (G1493). Typically these methods are used to treat water at only one faucet. Treatment units can furnish an adequate supply of defluoridated drinking and cooking water for the home. Work with a reliable, competent water treatment dealer to select the treatment method best for your situation.

Resources

Fluoride in Drinking Water: A Scientific Review of EPA's Standard; National Research Council; March 2006; (*www.nap.edu*).

Fluoride Facts; American Dental Association; 2005; (*www.ada.org/public/topics/fluoride/facts/index/asp*)

Oral Health in America: A Report of The Surgeon General; 2000; (*www.nidcr.nih.gov/DataStatistics/SurgeonGeneral/sgr*)

Fluoride In Nebraska Groundwater; Headrick, Jacqueline; 1996; M.S. Thesis; University of Nebraska

Review of Fluoride: Benefits and Risks; U.S. Public Health Service: February 1991; Report of the Ad Hoc Subcommittee to Coordinate Environmental Health and Related Programs; Washington, D.C. (*www.health.gov/environment/ReviewofFluoride/*)

Summary

All water contains naturally occurring fluoride. Fluoride is also added to some public drinking water supplies, a process known as fluoridation. At the optimum level, fluoride reduces the occurrence of dental decay. Elevated levels of fluoride in drinking water can cause fluorosis, or mottling of teeth. High levels consumed over a long period can cause chronic toxicity. Extremely high levels, significantly above those found in water, can cause acute toxicity. Tests by reputable, qualified laboratories can determine the concentration of fluoride in drinking water. If fluoride is present above a desirable level, options include using water treatment equipment to remove the fluoride or an alternative water source.

This publication has been peer reviewed.

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