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G98-1376 Drinking Water: Fluoride (Revised February 2005)

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G1376
(Revised February 2005)

Drinking Water: Fluoride

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This NebGuide discusses fluoride in domestic water supplies.

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 the 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 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). 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. Counties included in each area, and the average fluoride concentration for each according to a Nebraska

Health and Human Services System database used in the Headrick study, were: (see *Figure 1*) the Republican River Valley Area — Chase (0.8 mg/l), Dundy (1.0 mg/l), Hayes (0.8 mg/l), Hitchcock (0.9 mg/l), Red Willow (0.6 mg/l) and Frontier (0.7 mg/l); Knox County (0.5 mg/l with 32 percent of samples having concentrations greater than 1.5 mg/l); and the Panhandle Area — Box Butte (0.8 mg/l), Kimball (0.6 mg/l), Cheyenne (0.7 mg/l) and Scotts Bluff (0.5 mg/l). Scotts Bluff county, with an average concentration below 0.6 mg/l, was included because a USGS database also used by Headrick showed it had an average fluoride concentration of 0.8 mg/l. Fluoride concentrations reported in the two databases agreed within 0.1 mg/l for all other counties.

The Nebraska Health and Human Services System Department of Dental Health recommends a fluoride concentration of 0.7 to 1.5 mg/l in drinking water to prevent tooth decay. The Centers for Disease Control recommends a fluoride concentration of 1 mg/l as the optimum level to prevent tooth decay. Recommended fluoride levels in drinking water are discussed in the "Interpreting Test Results" section of this publication.

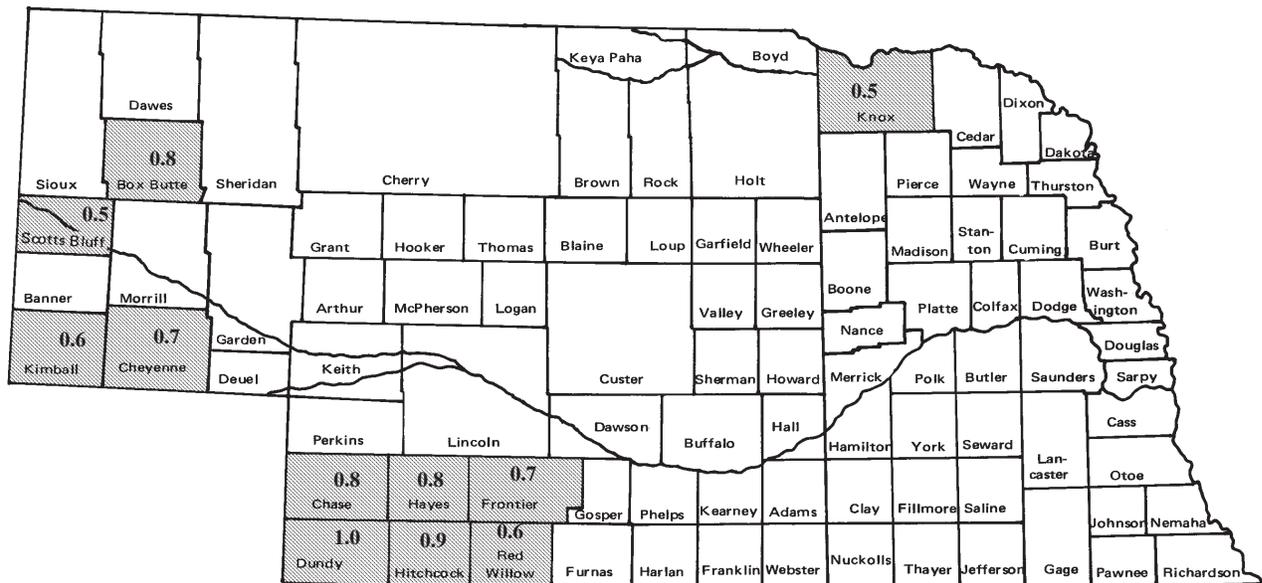


Figure 1. Counties with average groundwater fluoride concentrations (milligrams per liter) greater than 0.5 mg/l.

In the fall of 2004, HHSS reported that Nebraska public water supplies with naturally occurring fluoride at or near optimum levels include:

Abie	Haigler	Omaha Tribal Utilities
Alliance	Hayes Center	Oshkosh
Bartley	Hemingford	Palisade
Benkelman	Henry	Ponca
Big Springs	Homer	Sky Ranch Acres
Broadwater	Imperial	Stockville
Bushnell	Indianola	Stratton
Cambridge	Jackson	Trenton
Ceresco	Lebanon	Uehling
Chappell	Lyman	Verdel
Clarks	McCook	Walthill
Culbertson	Morrill	Wauneta
Grant	Nemaha	Wilcox Trailer Court
Gurley	Oakland	Winnebago

In some communities, fluoride is added to public water supplies; a process known as fluoridation. Water fluoridation involves adjusting the natural level of fluoride to the level recommended to prevent tooth decay. There is no difference in potential health effects between naturally occurring fluoride or that which is added through fluoridation.

In the fall of 2004, HHSS reported that the Nebraska public water systems listed below 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	<i>Rural Water District</i>
Albion	<i>#2</i>
Allen	<i>Salem</i>
Arlington	<i>Verdon</i>
Auburn	<i>Rulo</i>
Bassett	Fremont
Beatrice State	Fullerton
Developmental Center	Gering
Blair	Gordon
<i>Kennard</i>	Hallam
Bloomfield	Hartington
Blue Hill	Hickman
Cedar-Knox Rural Water	Holdrege
Project	Humphrey
<i>Crofton</i>	Kearney
<i>Fordyce</i>	Laurel
<i>St. Helena</i>	Lincoln
<i>Obert</i>	Lindsay
Coleridge	Louisville
Columbus	Lyons
Cook	Macy
Creighton	Magnet
Elgin	Metropolitan Utilities District
Elmwood	<i>Bellevue</i>
Emerson	<i>Bennington</i>
Fairbury	<i>Elkhorn</i>
<i>Little Blue Natural</i>	<i>LaVista</i>
<i>Resources District</i>	<i>Omaha</i>
<i>Rural Water District</i>	<i>Papio-Missouri River</i>
<i>#1</i>	<i>Natural Resources</i>
Falls City	<i>District - Washington</i>
<i>Richardson County</i>	<i>County</i>

<i>Fort Calhoun</i>	Red Cloud
<i>Paradise Lakes</i>	Rushville
<i>Ralston</i>	Ruskin
<i>Waterloo</i>	Scribner
Minden	Shelby
Nebraska City	South Sioux City
<i>Otoe County Rural</i>	Springfield
<i>Water District #1</i>	Stella
Neligh	Superior
Nelson	Syracuse
O'Neill	Tecumseh
Ogallala	<i>Johnson County</i>
Osmond	<i>Rural Water</i>
Papillion	<i>District #1 East</i>
Plattsmouth	Tilden
<i>Cass County SID #7 -</i>	Utica
<i>Swallow Hills</i>	Valley
<i>Cass County Rural</i>	Valparaiso
<i>Water District #1</i>	Wausa
<i>Murray</i>	Waverly
<i>Nehawka</i>	Wayne
	West Point

Fluoridation of drinking water can be controversial. Opponents argue fluoridation violates individual rights and goes against religious beliefs that ban medication. The courts have established fluoridation is not an unconstitutional invasion of religious freedom or other individual rights guaranteed by the First, Fifth or Fourteenth Amendments to the U.S. Constitution. It has been the position of courts that a significant government interest in health and welfare of the public generally overrides individual objections to public health regulation.

Opponents also argue that drinking fluoridated water promotes a variety of physical and mental ailments including sickle-cell anemia, cancer, cardiovascular disease, AIDS, Down Syndrome and Alzheimer's disease. Since the 1930's, many scientific studies have shown that water fluoridation, at the concentrations recommended for good oral health, has no harmful effects. A 1992 policy statement on water fluoridation by the Surgeon General of the U.S. Public Health Service and the Assistant Secretary of Health recommended fluoridation of community water supplies be continued in areas where naturally occurring fluoride levels are deficient.

Fluoridation is endorsed by both the American Dental Association and the American Medical Association, as well as numerous national and international organizations including the American Academy of Pediatrics, American Academy of Pediatric Dentistry, American Pharmaceutical Association, American Society of Dentistry for Children, Mayo Clinic, National Academy of Sciences, National Cancer Institute, National Health Council and U.S. Public Health Service Centers for Disease Control and Prevention, Food and Drug Administration and National Institute of Health.

Indications of Fluoride

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

Potential Health Effects

The dental benefits from consuming water containing optimum levels of fluoride are well-documented. The Ne-

Nebraska Health and Human Services System Division of Dental Health indicates that 0.7 to 1.5 milligrams per liter of fluoride in drinking water protects against tooth decay, reducing the incidence of dental caries (tooth decay), as well as aiding bone and tooth development. The American Dental Association has stated that fluoride benefits people of all ages. When children are young and their teeth are still 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 has been effective in decreasing problems with root caries (decay along the gumline).

Although low levels of fluoride are beneficial, excessive amounts can be harmful. Excessive fluoride in drinking water may produce fluorosis (mottling of teeth), which increases as the optimum level of fluoride is exceeded. Dental fluorosis appears during tooth formation and is caused by excessive fluoride ingestion, which leads to enamel protein retention, hypomineralization of the dental enamel and dentin and disruption of crystal formation. The effects range from barely perceptible white striations or specks on teeth to severe pitting and/or permanent brown to brownish gray stains on teeth. Continued consumption of water containing more than 2 mg/l fluoride will likely produce mild to moderate dental fluorosis. Continued consumption of water containing increasingly higher concentrations of fluoride will generally produce more severe dental fluorosis. However, according to the American Academy of Pediatrics, the effect of fluorosis is only cosmetic. Teeth affected by fluorosis seem to be resistant to dental caries.

Like other trace elements, excessive quantities of fluoride can result in acute or chronic toxicity. Consumption of an excessive amount of fluoride (300 to 750 milligrams depending on body weight) in a single dose can cause acute toxicity resulting in nausea or vomiting. This level of fluoride intake would only 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 1 mg/l, it would take ingesting 80 to 200 gallons of water to reach the acute toxicity level, an amount impossible to drink at any one time.

The National Academy of Sciences has studied the possibility of adverse health effects from continuous consumption of fluoride over long periods of time. The Academy reported daily intake required to produce chronic toxicity after years of consumption, is 20 to 80 milligrams or more per day depending upon body weight. This level of fluoride intake has been associated with water supplies containing at least 10 mg/l of natural fluoride, as in parts of India and where water consumption was high because of extreme climatic conditions. (U.S. Public Health Service Report of the Ad Hoc Subcommittee to Coordinate Environmental Health and Related Programs, 1991; and National Research Council Report of the Subcommittee on Health Effects of Ingested Fluoride, 1993.) **For information on possible health effects from chronic fluoride toxicity, consult your physician.**

Water supplies almost never reach fluoride levels capable of producing acute or chronic health effects naturally and never reach them when EPA primary and secondary fluoridation standards are followed. System surveillance

is important to guarantee EPA standards are followed in a fluoridated water system. Nebraska water supplies have never been documented with fluoride levels capable of producing an immediate health risk.

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.

Fluoride is present to some extent in all foods and beverages, and in many oral care products, such as toothpastes, mouth rinses and gels. **Consult your physician/dentist to develop a dental care plan that assures optimal fluoride exposure from water, food, topical treatment, and supplements.**

Testing

Testing Public Water Supplies

Public water supplies must be tested for fluoride concentration. If your water comes from a public water supply, contact your water supplier to find out the fluoride level. Check your water bill, check the yellow pages in your phone book, contact a city hall representative, or contact a village board member to determine how to contact your water supplier.

Testing Private Water Supplies

Water quality in private wells is not currently regulated in Nebraska; thus, the testing of a private water supply is not required. 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 HHSS approves laboratories to conduct tests for drinking water samples. Approval must be received for each specific contaminant. For information on laboratories approved to test for fluoride, contact HHSS as follows:

Nebraska Health and Human Services System
Department of Regulation and Licensure
Laboratory Services
3701 South 14th
Lincoln, NE 68502
402-471-8426

Interpreting Test Results

Public Water Supply Test Results

The quality of water supplied by Public Water Systems is regulated by the U.S. Environmental Protection Agency (EPA) and the Nebraska Health and Human Services Department of Regulation and Licensure. Drinking water standards established by EPA 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. Water with a contaminant at or below the Primary Standard has been determined, through risk assessment, to be acceptable for drinking every day over a lifetime, and does not pose a health risk. Both a recommended Secondary Standard and an enforceable Primary Standard have been established for fluoride.

The Secondary Maximum Contaminant Level (SMCL) for fluoride is 2 milligrams per liter (mg/l) which is equal to 2 parts per million (ppm). Water with a fluoride concentration at or below 2 mg/l does not present a health risk and should

not cause fluorosis. Fluorosis is not considered a health risk but does have an aesthetic impact on teeth. See the Potential Health Effects Section of this publication for more information on fluorosis.

The Primary Maximum Contaminant Level (MCL) for fluoride in drinking water is 4 milligrams per liter (mg/l) which is equal to 4 parts per million (ppm). Daily consumption of water with a fluoride concentration at or below 4 mg/l does not present a health risk, but could cause fluorosis if the level exceeds the SMCL of 2 mg/l.

Options

If naturally occurring fluoride exceeds optimum levels, or if the presence of fluoride in drinking water through fluoridation is not desired, consider water treatment or an alternative drinking water source, such as bottled water. For more on bottled water options, see NebGuide G02-1448 *Drinking Water: Bottled or Tap?* There are four treatment methods suitable for removing fluoride from drinking water, including activated alumina filters, distillation, reverse osmosis, and anion exchange. For more on reverse osmosis or distillation, see NebGuide G03-1490 *Drinking Water Treatment: Reverse Osmosis* and NebGuide G03-1493 *Drinking Water Treatment: Distillation*. Typically these methods are used to treat water only at one faucet. Point of use 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. If treatment is selected to reduce fluoride or other contaminants exceeding optimum or regulatory levels, the treatment will probably remove nearly all of the fluoride from the water. In these cases it may be necessary to use fluoride supplements, generally obtained by prescription from a doctor/dentist, for beneficial use.

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 of 1 mg/l, fluoride reduces the occurrence of dental decay. Elevated levels of fluoride in drinking water can cause fluorosis, or mottling of teeth. High levels, above those typically found in water, 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 presence and amount 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. If fluoride is removed from water by treatment, and it is desirable to have optimal levels of fluoride for the beneficial effects, it is likely necessary to add fluoride supplements to the daily diet.

Other Related Publications

Related Drinking Water Publications

- G04-1539 An Introduction To Drinking Water
- G02-1471 Decommissioning Water Wells: An Owner's Guide

Related Drinking Water Contaminant Publications

- G89-907 Testing for Drinking Water Quality
- G90-989 Drinking Water: Bacteria
- G96-1274 Drinking Water: Hard Water
- G96-1275 Drinking Water: Sulfates and Hydrogen Sulfide
- G96-1279 Drinking Water: Nitrate-Nitrogen
- G96-1280 Drinking Water: Iron and Manganese
- G96-1282 Drinking Water: Man-made Chemicals
- G97-1333 Drinking Water: Lead
- G98-1360 Drinking Water: Copper
- G98-1369 Drinking Water: Nitrate and Methemoglobinemia
- G02-1448 Drinking Water: Bottled or Tap?
- G04-1536 Drinking Water: Storing An Emergency Supply
- G04-1552 Drinking Water: Arsenic

Related Drinking Water Treatment Publications

- EC03-703 Drinking Water Treatment: An Overview
- G03-1488 Drinking Water Treatment: What You Need To Know When Selecting Water Treatment Equipment
- G03-1489 Drinking Water Treatment: Activated Carbon Filtration
- G03-1490 Drinking Water Treatment: Reverse Osmosis
- G03-1491 Drinking Water Treatment: Water Softening (Ion Exchange)
- G03-1492 Drinking Water Treatment: Sediment Filtration
- G03-1493 Drinking Water Treatment: Distillation
- G04-1496 Drinking Water Treatment: Continuous Chlorination
- G95-1255 Shock Chlorination of Domestic Water Supplies
- G03-1494 Drinking Water Treatment: Emergency Procedures
- NF02-505 Drinking Water: Chloramines Water Disinfection in Omaha Metropolitan Utilities District

Technical Review (1998 version) provided by:

- Julie Albrecht - University of Nebraska Cooperative Extension
- David Gosselin - University of Nebraska Conservation and Survey
- Connie Hancock - University of Nebraska Cooperative Extension
- Kim McFarland - Nebraska Health and Human Services System
- Adi Pour - Nebraska Health and Human Services System
- Wayne Woltdt, University of Nebraska Cooperative Extension
- Gary Zoubek - University of Nebraska Cooperative Extension

Technical Review (2004 revision) provided by:

- Michael Wentink, Nebraska Health and Human Services System
- Wayne Woltdt, University of Nebraska Cooperative Extension
- Gary Zoubek - University of Nebraska Cooperative Extension

References

- Headrick, Jacqueline; 1996; *Fluoride In Nebraska Groundwater*; M.S. Thesis; University of Nebraska.
- Fluoride Facts*; 1993; American Dental Association.
- U.S. Public Health Service; February 1991; Report of the Ad Hoc Subcommittee to Coordinate Environmental Health and Related Programs; *Review of Fluoride: Benefits and Risks*; Washington, D.C.
- National Research Council; August 16, 1993; Report of the Subcommittee on Health Effects of Ingested Fluoride, Committee on Toxicology, Board on Environmental Studies and Toxicology, Commission on Life Sciences; *The Health Effects of Ingested Fluoride*; National Academy Press; Washington, D.C.

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Revised February 2005

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