PENNSTATE

College of Agricultural Sciences Cooperative Extension

Agricultural and Biological Engineering

F-134

Removing Giardia Cysts From Drinking Water

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In the mid 1980s several Pennsylvania communities experienced outbreaks of a waterborne disease called *Giardiasis*. Hundreds of citizens suffered with symptoms ranging from mild nausea to acute, severe intestinal distress. How did the *Giardia* cysts enter drinking water supplies? Studies showed that the outbreaks occurred in communities with inadequate chlorination systems, improperly operated and maintained filtration equipment, and even unfiltered water supplies. Since water supplies are not regularly tested for *Giardia*, the contamination was not detected until it was too late and entire communities had been exposed to contaminated drinking water.

From a health standpoint, *Giardia* has no longterm health effects. However, EPA studies conducted in Pennsylvania communities reveal that even a single *Giardia* outbreak may require investment in high cost filtration systems. For residents receiving water from private wells, the presence of *Giardia* cysts from unfiltered water, although unlikely, may indicate that other contaminants are making it to the tap, as well. In either case, everyone will agree that the illness-causing cysts must be removed.

What is Giardiasis?

Giardiasis is a gastrointestinal illness caused by the introduction of *Giardia* cysts from human or animal wastes into water supplies. The microscopic cysts are capable of surviving in cold water for extended periods of time. Mammals, such as beavers, that spend time in or near water have been implicated in some *Giardia* outbreaks, but many animals as well as humans are known to carry the disease. Ingested by the host animal, the cyst develops into the adult protozoan life stage and attaches itself to the wall of the small intestine at the outlet of the stomach. There it reproduces cysts which can develop and infect other hosts. One gram of feces from an infected animal may contain as many as two million cysts. Diarrhea, abdominal cramps, and gas are among the common symptoms that may appear within 1-4 weeks after cyst ingestion.

Giardiasis affects persons of all ages. Medication will eliminate the organism from the intestines, but reoccurrence of the symptoms occurs in some individuals.

Preventing Giardiasis

Detection of *Giardia* cysts is difficult and often doesn't occur until an individual becomes infected. Testing water for *Giardia* requires filtering several hundred gallons of water and having a trained analyst inspect the filter with a microscope. If no cysts are present, there is still no guarantee that none exist in the water supply. The Department of Environmental Protection (DEP) currently samples public water supplies for *Giardia* and more stringently enforces regulations concerning proper operation and maintenance of water treatment plants to insure removal of the cysts. If you suspect that *Giardia* contamination has occurred, you should contact your local community water company or the DEP.

For individuals drawing water from private wells, the safeguarding of the water supply rests on the individual. Where deep (greater than 80') groundwater sources are used for water supply, *Giardia* cysts are usually not a problem. However, if surface water seeps directly into a well, *Giardia* can contaminate even the deepest well. A well casing that extends above the surface of the ground and is properly grouted will keep surface water out of the well.

Springs and shallow wells have high contamination probabilities because there is inadequate soil filtration of the water flowing into these systems.

Removing Giardia Cysts

Removing *Giardia* cysts before they reach the tap usually involves disinfection to inactivate the cysts and filtration through a fine media to physically remove the cysts from the water. Because *Giardia* cysts are resistant to normal disinfection, filtration is usually required. Cysts are large in comparison to bacteria and viruses (ranging from 7-10 microns in diameter); consequently, they are more easily removed by filtration.

Both disinfection and filtration processes are used in combination at municipal plants to protect water supplies and assure customers of high quality drinking water. Home water treatment techniques and devices are also available to assist water users in effectively removing *Giardia*. Techniques such as superchlorination, boiling, and manufactured treatment devices are available to the homeowner.

Because normal chlorine levels used to kill bacteria in water supplies will not inactivate *Giardia* cysts, **super chlorination** is required. Figure 1 shows a comparison of approximate chlorine levels necessary to inactivate bacteria compared to *Giardia* cysts. Not only is a higher concentration of chlorine in the water necessary but increased contact time is required. Super chlorination can effectively eliminate one-time contamination events. The strong smell and taste of chlorine at this level will make the water unpalatable for a short period of time.

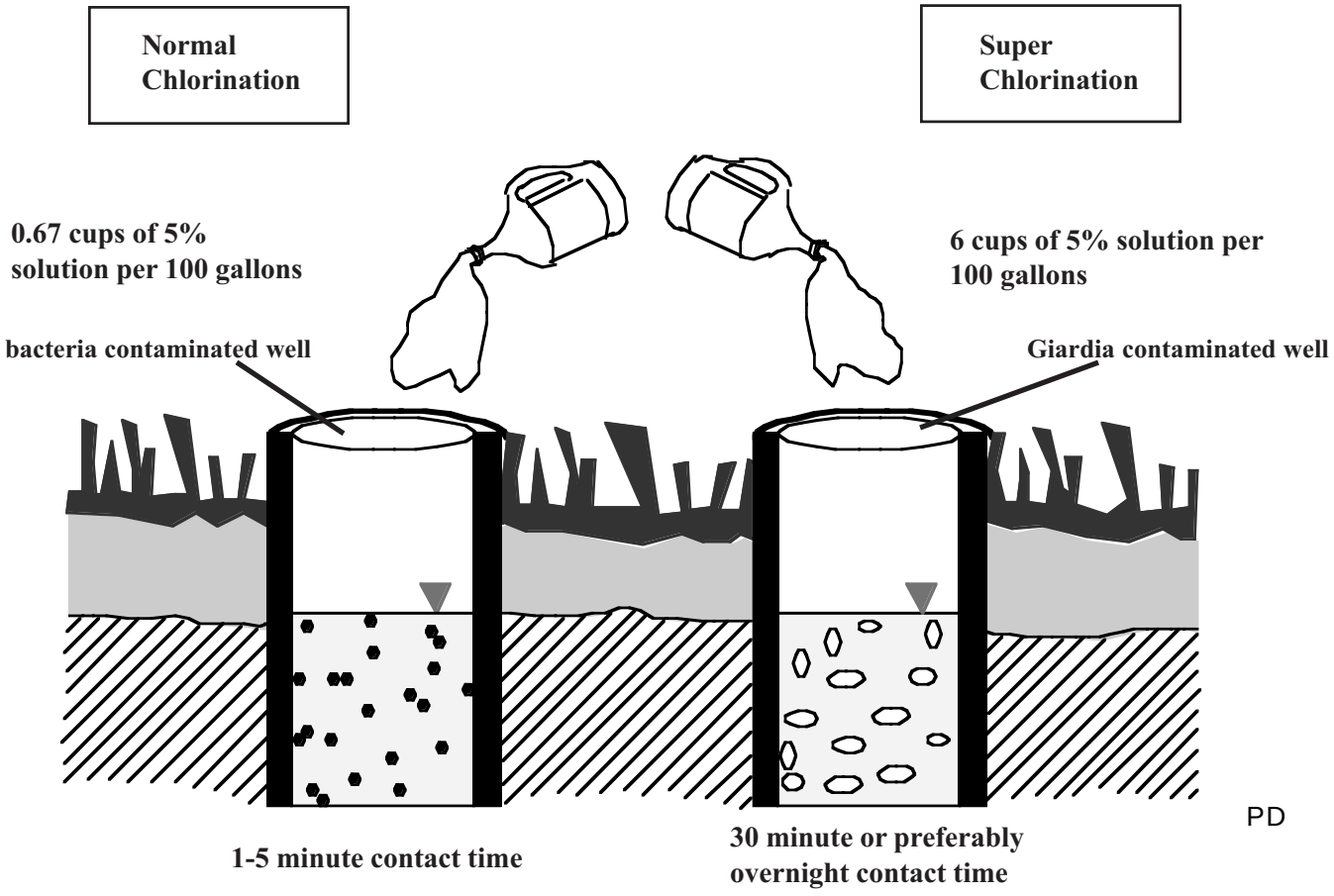

Figure 1. Comparison between normal and super chlorination for disinfection.

An alternative to chlorination is **boiling**. Boiling is a simple, effective means of killing *Giardia* cysts. It is also a method that can be used away from home on camping and hiking trips. To inactivate the cysts, bring water to a full boil for 1 minute on a stove or in a microwave. *The heat from a hot water tank is not sufficient to inactivate Giardia cysts.* Boiling water is a viable, temporary solution to giardia contamination. Since boiling often leaves water with a bland taste, you may wish to purchase bottled water in lieu of boiling drinking water (See F 142 *Bottled Water* fact sheet).

Manufactured treatment devices also remove *Giardia* cysts. Various **filters** are probably the most common devices used. They are constructed of very fine media that traps small particles like bacteria, cysts and sediment. Sand, diatomaceous earth, spiral wound fiber, ceramic and activated carbon are five common media used for filtration. Figure 2 shows how the filtration process works to trap *Giardia* and other water constituents. The most widely available filter for point-of-use/point-of-entry treatment is the activated carbon filter (ACF). Many types of ACFs are currently on the market. Tap mounted filters attach to the the faucet and pour through models work like automatic drip coffee makers. High volume models are installed under the sink.

Although many people believe that filters are a fail-safe treatment, filters are ineffective unless properly maintained and operated. As Figure 2 shows, where undisinfected water is used, filters are susceptible to bacterial growths which plug and coat the filters, reduce the filtering capacity, and create a source of bacterial contamination. For this reason, only disinfected water should be filtered. Filters must also be cleaned regularly and replaced. Filters such as the tap mounted type must be changed at least every six months. Read the manufacturers instructions to make sure that you are properly maintaining your filter.

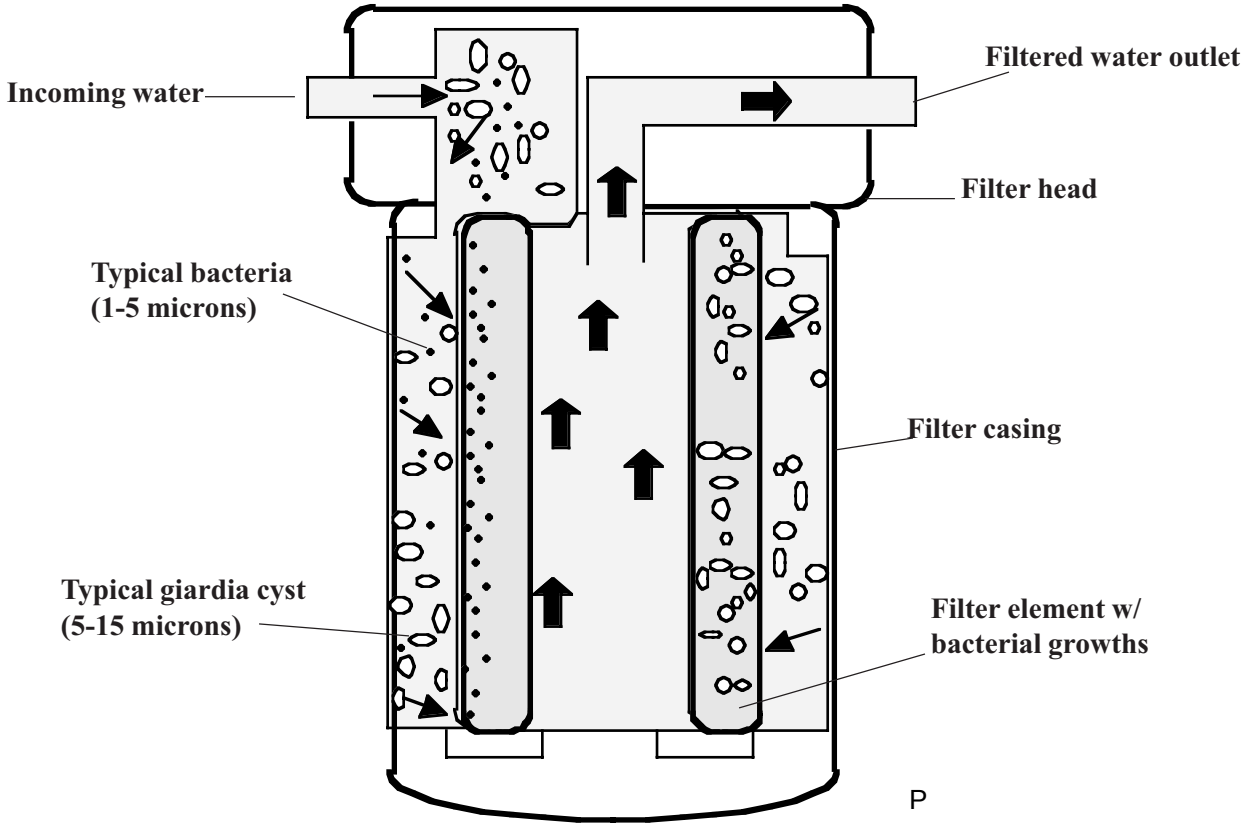

Figure 2. An activated carbon filter with a partially spent filter.

Other Disinfection Methods

A disinfection process widely used in European water treatment plants, is now emerging as a home treatment technology in the United States. Ozone, a strong oxidizing gas, is injected into water and kills bacteria and *Giardia* cysts with less contact time than other disinfection processes. Unlike chlorination, ozone leaves no after taste or residues and has been found to be more effective and more costly at *Giardia* deactivation than chlorine.

Some manufacturers have also marketed Reverse Osmosis (RO) and ultraviolet light equipment for *Giardia* treatment. Reverse Osmosis devices are compact units designed to force pressurized water through a semi-permeable membrane. Contaminants are left on one side of the membrane while clean water flows out the other side. Tests conducted on RO have shown that in the long run, the membrane becomes less and less effective at removing *Giardia* cysts. UV light, a process that passes water through a chamber housing a quartz mercury lamp, has also been shown to kill cysts. These processes have not proven to be consistently effective at *Giardia* removal; consequently, they are not recommended for this use.

Additional Resources

For further information and resources on drinking water quality:

see fact sheet F 101 *Drinking Water Publications from the Penn State College of Agricultural Sciences*

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PSU rev. 8/01