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Blue-Green Algae (Cyanobacteria) and their Toxins

This ***Water Talk*** document covers a wide range of topics related to cyanobacteria, their toxins, and your health:

Background

What are cyanobacteria?

Cyanobacteria is the scientific name for blue-green algae, or "pond scum." The first recognized species were blue-green in colour, which is how the algae got their name. Species identified since range in colour from olive-green to red.

Cyanobacteria form in shallow, warm, slow-moving or still water. They are made up of *cells*, which can house poisons called *cyanobacterial toxins*. A mass of cyanobacteria in a body of water is called a bloom. When this mass rises to the surface of the water, it is known as *surface scum* or a *surface water bloom*. Although we don't know the extent to which cyanobacterial blooms occur across Canada, we do know they mostly appear in the hot summer months and are quite prevalent in the prairies.

What are cyanobacterial toxins?

Cyanobacterial toxins are the naturally produced poisons stored in the cells of certain species of cyanobacteria. These toxins fall into various categories. Some are known to attack the liver (hepatotoxins) or the nervous system (neurotoxins); others simply irritate the skin. These toxins are usually released into water when the cells rupture or die. Health Canada scientists are more concerned about hepatotoxins than neurotoxins, because neurotoxins are not considered to be as widespread as hepatotoxins in water supplies. Very few cyanobacterial toxins have actually been isolated and characterized to date. Better methods of detection are being developed to help us learn more about them, especially to find out which toxins are a problem in Canada and what conditions encourage their production.

What are microcystins?

One group of toxins produced and released by cyanobacteria are called *microcystins* because they were isolated from a cyanobacterium called *Microcystis aeruginosa*. Microcystins are the most common of the cyanobacterial toxins found in water, as well as being the ones most often responsible for poisoning animals and humans who come into contact with toxic

blooms. Microcystins are extremely stable in water because of their chemical structure, which means they can survive in both warm and cold water and can tolerate radical changes in water chemistry, including pH. So far, scientists have found about 50 different kinds of microcystins. One of them, microcystin-LR, appears to be one of the microcystins most commonly found in water supplies around the world. For this reason, most research in this area has focused on this particular toxin.

Does the presence of a cyanobacterial bloom always mean the water is contaminated?

No. Researchers generally agree that between 30 and 50 per cent of cyanobacterial blooms are harmless because they contain only non-toxic species of freshwater cyanobacteria. Blooms containing even one species of toxic cyanobacteria will be poisonous and potentially dangerous. Because there's no obvious way to tell if a particular bloom is toxic, samples have to be analysed in a laboratory before a body of water can be declared safe.

Why do blooms sometimes appear overnight?

Even if you can't see a cyanobacterial bloom floating on the surface of the water, that doesn't mean one isn't present in the water - the bloom could be suspended at various depths in the water where you can't see it.

The depth at which cyanobacterial blooms float depends on a number of factors. The most important of these are light, phosphorus and nitrogen, which cyanobacteria need in order to survive. As the availability of these elements can change quickly with the time of day and the weather, most cyanobacteria have evolved to be able to control their buoyancy. By being able to sink and rise at will, they are able to move to where nutrient and light levels are at their highest.

In order to activate the mechanism that allows them to move, cyanobacteria need light. At night, when there is no light, cells are unable to adjust their buoyancy and often float to the surface, forming a surface scum. This scum literally appears overnight and lingers until the wind and waves scatter the cells throughout the water.

Are cyanobacterial blooms a new problem?

No. The earliest reliable account of a cyanobacterial bloom dates back to the 12th century; the toxic effects of cyanobacteria on livestock have been recognized for more than 100 years. Since cyanobacterial bloom formation seems to be linked to nutrient-rich water bodies (for example, water that contains a lot of phosphates from detergents and phosphate fertilizers), the problem is not likely to go away in the near future.

Effects on Humans and Animals

Can cyanobacterial toxins kill me?

Although many people have become ill from exposure to freshwater cyanobacterial toxins, death from algal-contaminated drinking water is unlikely to occur given that water resources are usually effectively managed to control taste, odour and other algae-related problems. It's possible that extended exposure to low levels of cyanobacterial hepatotoxins could have long-term or chronic effects in humans.

How will I know if I've accidentally come into contact with cyanobacterial toxins?

If you ingest water, fish or blue-green algal products containing elevated levels of toxins, you may experience headaches, fever, diarrhoea, abdominal pain, nausea and vomiting. If you swim in contaminated water, you may get itchy and irritated eyes and skin, as well as other hay fever-like allergic reactions. If you suspect you might have come into contact with cyanobacterial toxins and are experiencing any of these symptoms, rinse any scum off your body and consult your physician immediately.

Are children more vulnerable than adults?

Yes. Children are at greater risk than adults of developing serious liver damage should they ingest high levels of microcystins, because of their comparatively lower body weight.

Should I let my pets or my livestock drink water containing cyanobacterial blooms?

No. The animals could become extremely ill and even die. The first recorded episode of animal poisoning attributable to cyanobacteria occurred in Australia in 1878. Since then, there have been many widespread incidents of poisoning, affecting a variety of both wild and domestic animals. Animals are not more sensitive than people to the effects of the toxins; they are simply not as concerned with the way water looks or smells before they drink it.

Death is usually caused by damage to the liver or to the nervous system, depending on which toxins were predominant in the water. Treatments to counteract the effects of cyanobacterial toxins in animals have not been extensively investigated to date.

Issue: Drinking Water And Water Used For Dialysis Treatment

How likely am I to drink water contaminated with cyanobacteria and/or its toxins?

Not very likely. Relatively few incidents of human poisoning have been reported. People don't usually drink water con taminated with cyanobacteria because of the scum and the accompanying smell (fresh blooms smell like newly mown grass; older blooms smell like rotting garbage). However, people could unknowingly drink water containing cyanobacterial toxins released from blooms that have died naturally.

If your water comes from a source that is prone to blue-green algal contamination (dugouts, for example), you should monitor the water for bloom formation. If you detect a bloom in your water supply, contact your local health authorities for advice.

Can I cook using water with blue-green algae in it?

No! Boiling water does not remove toxins from the water. As it is impossible to detect the presence of toxins in the water by taste, odour or appearance, you must assume that they are present until testing is completed.

What about using contaminated water for washing?

If there is a safe source of water available, don't use contaminated water for washing clothes or dishes. If no alternative supply is available, use rubber gloves to avoid direct contact with the water. Bathing or showering in contaminated water should be avoided, as skin contact with the algae can lead to skin irritation and rashes.

Are cyanobacteria a year-round problem in water supplies?

No. Canadian water supplies are unlikely to contain cyanobacteria during the winter, although some hepatotoxins may linger.

How do water treatment plants deal with cyanobacteria?

Most municipal water treatment plants do not regularly look for cyanobacterial toxins in the water supply. However, because cyanobacteria have strong smells and tastes and interfere with certain water treatment processes, most municipalities with a history of blooms monitor their surface water supplies for cyanobacteria.

Once cyanobacteria are detected in the water supply, treatment plants can remove them in a number of ways. Conventional water treatment facilities can remove the cells by adding chemicals that bind them together. As the cells clump together, they become heavier and fall to the bottom of the reservoir or tank, where they can be easily filtered out.

While this method will remove cells, it will not remove potentially harmful cyanobacterial toxins. These can be removed using certain oxidation procedures or activated charcoal. Further research in this area is required.

Generally speaking, chemicals (such as copper sulphate) or any other treatment method that causes the cells to break down and release their toxins should not be used.

The best way to avoid the problems associated with cyanobacterial blooms is to prevent blooms from forming. This can be done by reducing the input of nutrients, such as phosphates, into the water source or by mixing the water in a reservoir.

Can I treat my water at home to remove blue-green algae and their toxins?

Although results vary, treatment options are available for the homeowner. However, devices for household treatment can be very expensive. As well, it is difficult to assess the performance and ensure the quality of these household devices. More research in this area is needed and is under way.

What is Health Canada doing to make sure our drinking water is safe?

Health Canada works with the provinces and territories to establish drinking water quality guidelines. The guidelines often take the form of maximum acceptable concentrations for substances found in drinking water supplies. A consultation document on microcystins prepared by the Secretariat of the Federal-Provincial-Territorial Subcommittee on Drinking Water recommends a maximum acceptable concentration of 0.0015 mg/L for total microcystins in drinking water, based on the toxicity of microcystin-LR. This proposed guideline is believed to be conservative, as it is based on a lifetime of daily exposure via the oral route, even though toxins will probably not be present in Canadian water supplies more than four or five months each year because of climatic conditions.

The Subcommittee has decided that it will not adopt this guideline until a practical analytical method for microcystins is available to all jurisdictions. Health Canada is currently developing such a method, and it should soon be available. Once the guideline is approved, some municipal water treatment plants may be required to monitor for the presence of microcystin-LR in their water supplies, especially if the source is prone to cyanobacterial blooms. Monitoring strategies will vary between provinces.

To obtain a copy of the consultation document on microcystin-LR or to learn more about Health Canada's drinking water program, please refer to either our English web site at http://www.hc-sc.gc.ca/waterquality or our French web site at http://www.hc-sc.gc.ca/eauqualite.

I am undergoing renal dialysis treatment. Am I more at risk than others?

While the proposed level of microcystins allowed for drinking purposes will not adversely affect the health of most people, patients undergoing renal dialysis treatment may be more susceptible to the associated health risks. Because dialysis patients receive dialysis two or three times per week (exposure to more than 300L of water per week), there is potential for dialysis patients to be exposed to elevated levels of these toxins.

Conventional surface water treatment processes are usually effective in removing the algal cells, but are not very effective at removing or destroying dissolved toxins, particularly from supplies that contain high levels of organic material. Specialized surface water treatment processes can reduce the toxin levels to below the drinking water guideline, but these levels (0.1-0.5 µg/L) are still of concern for dialysis patients.

As a dialysis patient, what can I do to reduce my risk of exposure?

If you think your water supply comes from surface water, you or your dialysis treatment provider, should ask your local treatment plant if this source water is prone to blue-green algae blooms. If, after contacting your source water supplier, you discover there may be microcystins in your water, sampling should be done to determine whether the toxins are in the dialysate (hospitals and treatment centres may already have additional treatment capacity in place to eliminate all toxins of this nature). Additional treatment of the water may be necessary. These treatments can range from granular activated carbon filtration followed by reverse osmosis to much more complex membrane filtration systems (e.g., ultrafiltration). The extent of additional treatment will depend entirely on the quality of the municipal water supply.

Issue: Recreational Water

Can water containing cyanobacterial blooms be used for recreational activities?

Unlike controls available with a drinking water source contaminated with cyanobacteria, there are very few options available once these algae accumulate in water used for recreational activities, such as swimming, boating, wind surfing and fishing. Blooms in recreational bodies of water are usually associated with unpleasant odours and offensive appearance on shorelines as the scum accumulates and decays. Although cyanobacterial toxins are probably not absorbed through the skin, they can cause skin irritation. The toxins, if present, can be absorbed from the water via ingestion or can become airborne and be absorbed via inhalation. Individuals should avoid swimming and other water-related activities in areas with dense blooms.

What should I do if I suspect water has been contaminated by toxic cyanobacteria?

Because all cyanobacterial blooms are potentially toxic, it's always best to stay away from contaminated water until it has been tested and declared safe. Even after the bloom is gone, it's a good idea to wait until health authorities declare the water safe before swimming in it. For example, in one study in which a bloom was treated with algicide, the toxins released by the dead cells took more than three weeks to disappear.

What is Health Canada doing to ensure the quality of recreational water?

The drinking water guideline for microcys ti ns will not apply to recreational water. To ensu re public safety, Health Canada is developing a separate guideline for microcystin-LR in recreational water.

Issue: Fish Consumption

Can I eat fish from contaminated water?

Microcystins can accumulate in the tissues of fish, particularly in the viscera (liver, kidney, etc.), and in shellfish. Levels in the tissues depend upon the severity of the bloom in the area where the fish or shellfish are caught or collected. In general, caution should be taken when considering the consumption of fish caught in areas of a water body where major blue-green algal blooms occur; in particular, the viscera of the fish should not be eaten.

Issue: Blue-Green Algal Products

Where do the blue-green algae used in food supplements come from?

Historically, large-scale harvesting of blue-green algae masses was done for research purposes, to study their properties, their possible use as therapeutic and antibiotic agents, and their potential as agricultural commodities. Today, the algae used to manufacture blue-green algal products are harvested from controlled ponds or natural lakes. Before or during harvest, some types of algae will naturally produce chemicals such as microcystins, and these toxins could be retained in the blue-green algal products.

What is Health Canada doing about this situation?

A broad sampling and testing of blue-green algal products was recently performed by Health Canada to measure the levels of microcystins in blue-green algal products available on the Canadian market and to determine the level of risk to Canadian consumers. Results of the testing, conducted at three separate laboratories, indicate that no microcystins were detected in blue-green algal products containing only the blue-green algae *Spirulina*. However, for many non-*Spirulina* blue-green algal products, particularly those harvested from natural lakes, when consumed according to manufacturers' directions, the resulting daily intake of microcystins was above that considered acceptable by Health Canada and the World Health Organization.

Health Canada's Food Directorate has communicated the test results and their health significance to the Canadian Food Inspection Agency (CFIA), and has indicated that products on the Canadian market, when consumed according to the manufacturers' directions, should not exceed the daily intake of microcystins considered acceptable by the World Health Organization and Health Canada. Subsequent compliance measures are the responsibility of the CFIA.

Should I stop taking my blue-green algal supplements?

Blue-green algal products are sold in some pharmacies and health food stores as food supplements, often in tablet or caplet form. Health Canada is advising consumers to apply caution in their use of the products until evidence of their safety can be firmly established. In particular, adult consumers who choose to use products containing non-*Spirulina* blue-green algae should do so for short periods of time only. However, consumers can safely use products made only from *Spirulina* blue-green algae as these were found to be free of microcystins.

What about my child, who takes these tablets as a treatment for Attention Deficit Disorder?

Health Canada has not received adequate scientific evidence that supports the claim for use of blue-green algae as an effective treatment for Attention Deficit Disorder in children and has not authorized the marketing of any blue-green algal products for any therapeutic purpose. Most of the blue-green algal products in Canada are sold as foods, and Health Canada does not allow therapeutic claims for substances sold as foods. Meanwhile, because of their lower body weights, there is a potential risk of children being exposed to harmful levels of toxins if they ingest blue-green algal products, particularly if they ingest the products for an extended period of time.
As a precaution, Health Canada is recommending that the use of non-*Spirulina* blue-green algae by children be discontinued until follow-up measures have been implemented.

Where can I get more information?

Information related to blue-green algal products can be found at:
food and nutrition.

Last Updated: 2004-02-26  Important Notices