The Cooperative Research Centre for
Water Quality and Treatment

Drinking Water Facts

Blue Green Algae: A Guide

Blue-green algae are a natural feature of aquatic environments, but when environmental conditions cause them to bloom, they can threaten the quality of drinking water supplies.

A BIG PROBLEM

Algal blooms can cause major problems. With an unsightly appearance and often also a pungent smell, they can make affected water unappealing for recreational activities, such as swimming, boating or fishing. Water affected by a bloom is unsuitable for agricultural use.

However, it is when blooms form in drinking water storages, such as reservoirs or dams, that they can cause serious difficulties for drinking water suppliers.

Some species of blue-green algae produce chemicals that taint drinking water with musty or earthy tastes and odours. These off-tastes and odours require extensive treatment to remove and in severe cases make the water undrinkable. This can place significant strain on the water supply system.

More significantly, some species produce toxins that can be hazardous to animals and people if they are consumed, inhaled or possibly contact the skin.

WHAT ARE THEY?

Despite their name, blue-green algae are not algae at all. They are photosynthetic bacteria, also called 'cyanobacteria', that rely on sunlight for energy.

Blue-green algae are present in almost all aquatic ecosystems, including creeks, rivers, lakes and wetlands. Individual cells are very small, so blue-green algae can be present in a water body without being visible.

As environmental conditions become more favourable, algae numbers start to increase rapidly and blooms, or scums, become easily visible on the water surface. Blooms range in colour from dark green to yellowish–brown and develop a paint-like consistency as they dry out at the water's edge. A blue pigment may also be seen as they dry.

Unsightly blue-green algae blooms can prevent the recreational use of waters.

Issue 3. Nov 08

HIGHLY TOXIC

Blue-green algae produce three main types of toxin:

• **Hepatotoxins** damage the liver and may also increase the risk of certain types of cancer.

• **Neurotoxins** damage nerves and can cause muscle tremors, especially in the muscles animals and people need to breathe.

• **Allergens** are thought to produce a range of reactions including skin rashes, irritation of the eyes, and possibly gastroenteritis.

To put the toxicity of blue-green algae in perspective, the potency of pure saxitoxin (one of the common cyanobacterial toxins in Australia) is similar to the toxins of the common tiger snake, taipan and common brown snake when injected into mice.

Although human poisoning and illness from exposure to these toxins is rare, it can be severe and even fatal. The best-documented case of human deaths occurred in Brazil, where around 75 dialysis patients died after direct exposure to toxins in their dialysis fluid.

Blue-green algal toxins are colourless, odourless, and can remain present in the water weeks after the blue-green algae have disappeared. They are not destroyed by boiling affected water.

NOT NEW

Algal blooms are not a new phenomenon, and are known to have occurred for centuries.

The first scientifically documented case of an algal bloom causing deaths was in South Australia's Lake Alexandrina in 1878, where cattle, pigs and sheep died within hours of drinking contaminated water.

Algal blooms can cover large areas of a water body and last weeks. The largest algal bloom ever recorded in a river covered almost 1000 kilometres of the Barwon and Darling Rivers in November 1991. For nearly three weeks, river water was unsuitable for watering livestock, and the people who relied on the river for drinking water had to find other sources.

Massive algal blooms have been found in lakes and reservoirs around the world on virtually all continents, and in many cases have disrupted drinking water supplies. The increasing occurrence of blooms over the last 60 years has been linked to the process called 'eutrophication' which is the enrichment of water with nutrients from human population growth and associated activity.

Blue-green algae can cause serious problems in drinking water storages.

HOW BLOOMS FORM

Like all photosynthetic organisms, blue-green algae rely on sunlight for energy, with their growth rate determined by the level of nutrients available in the water.

Most bloom-forming blue-green algae have pockets of gas, called 'vacuoles', that allow them to control their buoyancy.

These gas pockets can keep the algae near the water surface, where they are able to build up their energy stores. As they convert energy from the sun to carbohydrate they become heavier and slowly sink down, where the water is higher in nutrients. As they use up their carbohydrate stores, they become lighter and start to rise to the surface again.

This ability to move within the water column can give blue-green algae an advantage over the other micro-organisms that compete for the same food. The advantage is lost, however, as soon as the water becomes turbulent. Their gas pockets cannot keep them afloat in a turbulent water column, lessening their competitive advantage and so reducing the growth rate of the population.

These gas pockets are the reason that turbulence is the most important factor in determining whether a bloom will form or not. Waters that flow slowly with low turbulence – such as regulated rivers, dams, or water storages – are at particularly high risk of algal blooms.

There are some exceptions to this. For instance, some species of blue-green algae do not form surface blooms and can be found concentrated down to depths of 20 metres.

Nutrient levels, while important, do not usually trigger a bloom. They only determine how large it becomes.

Blooms are likely to form when:

- The water is relatively still
- Nutrient levels are high
- Temperatures remain warm.

Most blooms do not last long, often disappearing within days or weeks. However, when conditions remain favourable, blooms can last months, especially if nutrient levels are high.

TESTING AND MONITORING

Although most surface blooms are obvious to the naked eye, blue-green algae can be present in the water without a visible bloom. To find out whether blue-green algae are present, how concentrated they are, and whether they are potentially toxic, experienced laboratory workers assess samples of the water using high-powered microscopes.

Once they have confirmed that blue-green algae are present, additional tests, such as bioassays or chemical analyses, are needed to find out whether they are toxic.

This process can take days and can sometimes delay control actions.

To speed up the process and help water resource managers respond to outbreaks more quickly, researchers are developing new tools. A new genetic technique uses PCR (polymerase chain reaction) to rapidly identify toxic blue-green algae strains within hours, using DNA flags to detect toxin-producing genes. New antibody-based screening assays are also becoming available for detection of the toxins.

GUIDELINES FOR SAFETY

The Commonwealth Government's National Health and Medical Research Council (NHMRC) produces the Australian Drinking Water Guidelines to provide advice to water suppliers.

The Guidelines recommend safe limits for various compounds found in drinking water, including blue-green algae toxins. They also contain fact sheets that give information about blue-green algal toxins.

They contain an up-to-date summary of the current knowledge on the health significance, management and water treatment of the four major classes of blue-green algae toxins encountered in Australia.

The fact sheets are available from http://www.nhmrc.gov.au/

Because blue-green algae can be toxic on contact, not just when consumed, the hazards they pose in recreational waters must be assessed by health authorities on a case-by-case basis. All contact with affected water should be avoided. Guidelines have also been developed by the NHMRC for acceptable levels of exposure to cyanobacteria in water used for recreation.

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PREVENTING AND CONTROLLING ALGAL BLOOMS

Blue-green algal blooms are a natural part of the aquatic environment. As it is likely that water resource managers will never be able to completely control algal blooms, research and management of blue-green algae emphasises control and treatment in important water supplies.

A number of strategies are recommended to avoid or manage blooms, including:

- Physical controls, such as artificially mixing the water column to create turbulence
- Minimising nutrient levels in water storages
- Restricting light onto the water surface. For instance, covering tanks or dams.
- Taking water from different parts of the reservoir
- Chemical controls, such as algicides.

Bloom control is complicated by the fact that as cells die and begin to break down, the toxins are released into the water. Cells may also release toxins as they grow. Water resource managers need to be aware that any control method that causes the cells to burst (for instance, the application of algicides or chlorination) can cause toxins to be released into the water, in some cases then making them harder to treat.

TREATING BLOOMING WATER

Modern treatment technology is highly effective at making water affected by blooms safe and palatable to drink.

When processing water affected by algal blooms, treatment plant operators will adjust their normal regime so that they remove the algal cells, the off-tastes and odours they produce, and most toxins. They use a combination of flocculation, filtration, chlorination and activated carbon.

If alternatives sources are available, water suppliers may stop taking water from a storage affected by a bloom.

More information about water treatment processes is available from the CRC for Water Quality and Treatment's publication, *A Consumer's Guide to Drinking Water*, available from www.waterquality.crc.org.au.

WHAT NEXT?

The CRC for Water Quality and Treatment has carried out an extensive research program on many aspects of understanding and managing algal blooms. Projects have included, developing methods to rapidly measure algal toxins in drinking water, investigating water treatment methods for removal, and controlling cyanobacterial blooms in both reservoirs and rivers.

The research is also focussing on health effects of cyanobacteria to allow for the development of better guidelines for both drinking and recreational waters.

COMMON SENSE TIPS

- Do not drink untreated water, whether you can see a bloom on the surface or not. As well as presenting possible health risks from algal blooms, untreated water can cause other illnesses.
- If you suspect that there are blue-green algae in water you use for any purpose (including drinking, cooking, washing, or showering), stop using it until the water has been investigated by an accredited laboratory.
- Boiling affected water does not destroy blue-green algal toxins.
- Do not swim in water containing visible blooms.
- If blooms are present, do not let livestock or pets drink or swim in the affected water. Provide alternative sources of drinking water

FOR MORE INFORMATION

visit the Web site:
www.waterquality.crc.org.au

The Cooperative Research Centre (CRC) for Water Quality and Treatment is Australia's national drinking water research centre. An unincorporated joint venture between 30 different organisations from the Australian water industry, major universities, CSIRO, and local and state governments, the CRC combines expertise in water quality and public health.

The CRC for Water Quality and Treatment is established and supported under the Federal Government's Cooperative Research Centres Program.

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