

## Blue-green algae and microcystin toxins

The microalgae industry has developed to its current status by providing a safe and nutritious product for the human supplement market as well as the animal and aquaculture feed markets. The vast majority of this microalgae biomass is produced from *Spirulina*, *Chlorella*, and *Aphanizomenon flos-aqua*. Concern over the discovery of toxic algae blooms in Klamath Lake underscore vital differences between cultured *Spirulina* and species of wild lake-grown algae. Scientists believe there are over 30,000 species of microscopic algae. The immense range of species includes nutritious varieties like *Spirulina* and *Chlorella*, as well as potentially dangerous species such as the *Microcystis* strains identified in Upper Klamath Lake. In this way, microalgae are similar to mushrooms—common cultured table mushrooms are absolutely safe and healthful while others, such as toadstools can be poisonous. The same situation occurs in the bacterial group—some, like the lactobacilli are essential for good digestion while others, such as *Salmonella* can cause disease.

Cultured *Spirulina* can be grown free of contaminating algae for several reasons. The growing conditions for *Spirulina* are unique as it is cultivated and thrives in very alkaline conditions. Competitor algae and other contaminants simply cannot compete and grow under these harsh conditions. Ponds are monitored and analyzed every day and carefully controlled to maintain a balanced chemistry. Samples are carefully scrutinized on a daily basis via microscopic testing to assure purity and cleanliness. Water runoff from outside sources cannot enter the raised raceways that cultivate *Spirulina*. Thus, there is no possibility for agricultural waste such as pesticides and herbicides to contaminate the cultures. Finally, as a precautionary measure, lots are periodically screened for cyanotoxins, none have been detected in Hawaiian *Spirulina* cultures.

Cyanotoxins have long been recognized as a water-based disease that causes animal illness and death. The biotoxins, microcystin and nodularin, have been implicated in causing irreversible hepatotoxicity and tumor promoting reactions laboratory rats, Evidence in China suggests a correlation between microcystins in drinking water and primary liver cancer. Australia, Canada, and Great Britain are moving to establish maximum acceptable concentration (MAC) of microcystins in drinking water, which are in parts per billion. In Australia a limit of 1 ppb (1 µg/liter) has been proposed. The June 1994 Criteria Document on Microcystin-LR for Canadian drinking water recommends a MAC of 0.5 ppb (0.5 µg/liter) for microcystin-LR and 1 ppb (1.0 µg/liter) for total microcystins. An even lower level of 0.01 ppb (0.01 µg/liter) has been proposed for Chinese waters based on research and levels of microcystins found in drinking local water. Because of the risk for cancer and liver damage, further research is needed to elucidate the dose-dependent effects of microcystins. Excellent reviews of cyanotoxins, microcystins, and nodularins have been published recently (Carmichael; 1992, 1994, 1997).

Despite the controlled conditions, precautions, quality control, and proven safety of *Spirulina*, consumers often confuse or associate *Spirulina*, with wild *Aphanizomenon flos-aqua* which is vulnerable to toxic microcystin and nodularin contamination. As a result of these concerns, Cyanotech Corporation, Earthrise Farms (Calipatria, CA), and other international

*Spirulina* and *Chlorella* manufacturers formed a consortium in 1995 to jointly fund a phytotoxin research project. This research was performed in the laboratory of Dr. Wayne Carmichael (Wright State University) and resulted in a very sensitive assay for microcystin and nodularin toxins in algae products. The project generated a technical booklet for the microalgae industry entitled "Detection of microcystins and nodularins using an enzyme linked immunosorbant assay (ELISA) and a protein phosphatase inhibition assay (PPIA)". The PP2A inhibition assay is 1000 times more sensitive than the HPLC or mouse bioassay (0.05 ng/ml) and the ELISA assay method for the detection of microcystin and nodularin is sensitive to 0.002 ng/ml.

Cyanotech Corporation has been a producer of *Spirulina platensis* and other microalgae products for over 10 years in accordance with Good Manufacturing Practice. The Hawaiian production facility has ISO 9002 certification, which requires internationally recognized quality assurance procedures. Quality control is assured on-site by technicians who conduct chemical and microbiological assays to guarantee the purity of the ponds and final product. Consumer safety of our product is of utmost priority. *Spirulina* received GRAS (Generally Recognized As Safe) by the FDA in 1981, whereas *Aphanizomenon flos-aqua* has never been granted this status. Unlike blue-green algae harvested from uncontrolled lakes, *Spirulina* that is cultivated under carefully controlled conditions should not have cyanotoxin contamination.

## References

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