

Persistence and proliferation of some unicellular algae in drinking water systems as result of their heterotrophic metabolism

Francesc Codony*, Anna M Miranda and Jordi Mas

Department of Genetics and Microbiology, Autonomous University of Barcelona, E-08193 Bellaterra, Spain

Abstract

Drinking water systems have a complex structure and are characterised by the absence of light, the presence of disinfectants and by low levels of nutrients. Several kinds of bacteria, protozoa, algae and fungi can be found in tap water. Little is known about the ecology of algae in drinking water systems, although their capacity to produce toxins and modify taste and odour has been described. In order to assess the presence and persistence of unicellular algae as well as their ability for heterotrophic growth as a mechanism for survival in water distribution networks, we carried out a one year study of the drinking water from the Bellaterra campus of the Autonomous University of Barcelona. Unicellular algae were isolated by membrane filtration on plates of synthetic medium containing organic matter as an energy source (R2A).

Oocystis sp. (unicellular green algae) and *Xenococcus* sp. (cyanobacteria) were routinely isolated and cultured using the procedure mentioned above. The results demonstrate the ability of some microalgae to grow in the dark as a consequence of their heterotrophic metabolism and illustrate the probable survival mechanism of some algal species in these systems, which can be related to the possibility of algae regrowth in drinking water systems.

Introduction

Drinking water is a particular ecosystem with special characteristics such as the absence of light, the presence of disinfectants and the existence of low nutrient levels. From origin to destination, through kilometres of pipes with different diameters and materials, water flows through different pumping stations, deposits and booster chlorination points.

Water supply released into the distribution system evolves during its passage throughout the system as consequence, to a large extent, of microbial activity. These quality changes most often cause taste, odour and colour complaints. In other cases, as result of bacterial regrowth, the sanitary quality of water decreases, therefore resulting in non-compliance with national regulations.

Most components in water distribution networks may become excellent microbial environments. However, the persistence and proliferation of microorganisms in these systems is influenced by a number of factors (Geldreich, 1996). Most exposed surfaces are colonised by microorganisms, forming biofilms (Ridgway and Olson, 1981). The characteristics of these biofilms vary widely, from sparsely colonised surfaces, to thick complex layers with a depth of several micrometers formed by a densely interwoven structure of extracellular polymers and microbial cells (Lechevallier et al., 1987; Stewart et al., 1993). Microbial growth within the biofilm and release of the offspring into the overlaying water contributes to increased microbial counts in the water phase. On the other hand, the structure of the biofilms contributes to shelter occasional contaminants from the effects of chlorine, thus prevent-

ing adequate disinfection and potentially allowing regrowth of contaminants in the water distribution network (Lechevallier et al., 1988; Camper, 1994). Evidence is available that shows the development of biofilms containing algae (Allen et al., 1980).

Microbiological quality of drinking water is systematically controlled by water suppliers using the levels of microbial indicators such as total and faecal coliforms, or heterotrophic plate counts (HPC) as reference. The microbial indicators routinely used, are good tools for the sanitary control of water but they only offer a partial view of the microbial dynamics. Therefore, the vision obtained with standard microbial analysis is not enough to understand the full complexity and diversity of drinking water systems. In tap water we can find several kinds of bacteria, protozoa, algae and fungi.

Algae can affect water characteristics in two ways. First, as occurs with actinomycetes, algae can alter organoleptic properties (Nyström et al., 1992; Jensen et al., 1994; Bower et al., 1988). Second, certain cyanobacteria can produce toxins with pernicious health effects (Codd, 1995; Sivonen, 1996). Cyanobacteria and their toxins can cause diarrhea as an acute effect and cancer in the ultimate instance (Rose et al., 1999).

The inclusion of cyanobacteria, freshwater algae and their toxins in the drinking water contaminant candidate list (CCL) U S Environmental Protection Agency (EPA) in 1998, illustrates the increasing interest in such micro organisms and their possible impact on public health.

The CCL is a list of contaminants which, at the time of publication, are not subject to any proposed or promulgated national primary drinking water regulation, but which are known or expected to occur in public water systems, and may require regulations. CCL will be the primary list of priority contaminants for the agency's drinking water program (U S EPA, 1998a; b). For this microbial group the research of analytical methods has been pointed as one of the priorities.

* To whom all correspondence should be addressed.

New address: Laboratori de Salut Pública de Barcelona, Avinguda Drassanes 13-15, e-08001 Barcelona Spain

☎ 34 93 443 94 05; fax 34 93 443 06 11; e-mail: fcodony@dtb.scs.es

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