**- REVUE GÉNÉRALE - Y a-t-il des infections bactériennes opportunistes transmises par les eaux d'alimentation ?**

**Journal Européen d'Hydrologie, tome 34, fasc. 1, 2003, p. 11 à 44** **HENRI LECLERC,**

Notre environnement tellurique, aquatique, aérien, végétal est peuplé de bactéries hétérotrophes qui jouent un rôle essentiel dans le cycle de la matière organique. Il peut être contaminé par des bactéries pathogènes provenant de l'homme et des animaux, également hétérotrophes (bactéries entériques telles que Salmonella, Shigella, bactéries à tropisme pulmonaire telles que les Legionella) ainsi que par des germes indicateurs tels que les coliformes. Le test HPC est un test mondialement reconnu et utilisé pour mesurer la population bactérienne hétérotrophe dans les eaux d'alimentation (distribuées en réseaux ou embouteillées). De nombreuses méthodes ont été décrites au cours du temps pour mesurer les bactéries HPC. Elles sont caractérisées par la composition et les modes d'ensemencement du milieu, le temps et la température d'incubation. L'historique de ces méthodes et leur diversité ont été décrites par Reasoner (1990). Les données obtenues sont différentes selon les méthodes et l'objectif recherché est de sélectionner les meilleures variables pour obtenir les plus hautes concentrations de microorganismes, si possible dans le minimum de temps. Il est important de souligner que (1) le test HPC ne peut mesurer qu'une fraction des bactéries hétérotrophes présentes dans le milieu, c'est-à-dire celles qui sont cultivables dans les conditions choisies ; ce pourcentage peut être inférieur à 1 % voir 1‰ du nombre total de bactéries comptées en acridine orange ; (2) le test n'est pas capable de faire la différence entre bactéries pathogènes et non pathogènes ; (3) certaines bactéries pathogènes comme les Legionella et les mycobactéries du complexe avium ne peuvent pas se développer dans les conditions du test.

Heterotrophic Plate Counts and

Drinking-water Safety

The Significance of HPCs for Water Quality

and Human Health

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**9.3 CULTURE-BASED (TRADITIONAL) METHODS**

The traditional approach for drinking-water microbiology has been the monitoring of water quality using microbial indicator organisms, including socalled "total heterotrophs," by culture in artificial media (Standing Committee of Analysts 1994; WHO 1996; APHA et al. 1998). Such tests are relatively inexpensive and reproducible, yet we know they severely underestimate the total number of heterotrophic bacteria by up to several orders of magnitude (Amann et al. 1995; Sartory and Watkins 1999), even with extended incubation times and changes in temperature (Elzanfaly et al. 1998). It has long been recognized that artificial culture media lead to only a very small fraction (0.01–1%) of the total viable bacteria present being detected (Watkins and Xiangrong 1997). Furthermore, introduced bacteria progressively deteriorate in aqueous environments, with some initially able to be grown on selective media (described in Table 9.2), then only on non-selective media (socalled stressed cells), and finally becoming non-culturable (so-called viable but non-culturable [VBNC] if still capable of

causing infection) (McFeters 1990; Colwell et al. 1996; Cervantes et al. 1997). Therefore, despite considerable financial/legal costs associated with culture-based results (and associated quality control methods provided in Table 9.2), application of selective agents in any culture-based method, including those for pathogens, is likely to lead to considerable underestimation of the actual number of potentially infective bacteria present.

### 11.3.4 Adenosine triphosphate

For determining the concentration of active microorganisms, the adenosine triphosphate (ATP) assay has been developed. ATP is an energy-rich compound present in active biomass. The first applications of the ATP analysis for determining microbial activity in water were described by Holm-Hansen and Booth (1966). Values of 250–300 have been reported for the ratio between concentrations of biomass estimated as particulate organic carbon and ATP (Karl 1980). Attractive properties of this analytical method include the following: • rapidity: the analysis can be conducted within a few minutes; • low detection level: a concentration of 1 ng ATP/litre can be detected without concentration techniques; • inclusion of all types of active (micro)organisms; • ease of interpretation, because ATP concentration is directly related to activity; • automation: enables the analysis of large series of samples; and • on-site analysis, using portable equipment. Improvements of the chemicals and equipment will lead to further decreases in detection limits and improve ease of operation. ATP analysis is used as a research tool for assessing the presence of microorganisms in drinking-water. In a study conducted in 19 water supplies in the Netherlands, it was found that ATP concentrations in treated water collected 208 HPC and Drinking-water Safety from the distribution systems (mostly without chlorine residual) were usually below 10 ng/litre (Figure 11.2). The HPC/ATP ratio in groundwater supplies (105 – 3 × 105 cfu/ng) was lower than in surface water supplies (106 – 3 × 106 cfu/ng), probably because of the presence of nitrifying bacteria coming from filter beds used in groundwater treatment (van der Kooij 1992). Deininger and Lee (2001) observed a high correlation between ATP concentrations and HPC values in 120 samples collected from various systems in the USA. Relatively high ATP concentrations (up to 50 ng/litre) have been reported for a distribution system receiving ozonated water (Bourbigot et al. 1982). A survey of all supplies in the Netherlands showed that ATP concentrations in water leaving the treatment plant were below 1 ng/litre in 15% of the samples, with 2.5 ng/litre and 8 ng/litre as median value and 90th-percentile value, respectively (Figure 11.3). Hence, a database for this parameter in treated water is available for reference. Figure 11.2.