Heterotrophic Plate Count Bacteria and Drinking Water

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Heterotrophic Plate Count (HPC) is a nonspecific term for the growth of viable, naturally occurring bacteria in water. It has been used to evaluate not only the overall quality of finished water, but also as a gauge for the maintenance of disinfection residuals, the detection of the absence of bacterial regrowth and the effectiveness of water treatment in general.

Because these organisms are naturally present in finished water, they are accustomed to growth in what are considered very nutrient-poor environments. Similarly, the media used to isolate this group of microbes is a nonselective, low nutrient, solid gel matrix known as R2A agar, which also allows for growth of a variety of organisms accustomed to highly purified water environments.

The media and growth conditions utilized during this isolation define an HPC. The term may encompass bacterial strains of *Arthrobacter, Aeromonas, Alcaligenes, Chromobacterium, Pseudomonas, Sarcina, Micrococcus, Flavobacterium, Proteus, Bacillus* and others. Water samples are spread onto gelatinous media rounds and allowed to incubate for 5-to-7 days at room temperature, in order to mimic the environment in which these organisms are most adept at surviving. Positive results are determined by the growth of concentric bacterial colonies on the media plate that may be easily enumerated (see *Figure 1*). One important note is that most heterotrophic bacteria in water are not human pathogens.

HPC in POU treatment

Original water quality parameters appear to be important in the regrowth of HPC bacteria in distribution systems and point of use (POU) treatment devices. Regrowth is related to such factors as the loss of free-chlorine residual, the type of water, temperature, turbidity, construction materials and the level of organic matter in the finished water.[6] Additionally, there is a direct correlation between residence time, or the time the water sits in reservoirs and distribution systems, and bacterial density.[2] Therefore, regular maintenance and bio-control of storage tanks and distribution lines are factors to consider when attempting to minimize bacterial counts in drinking water.

A 1980 study of chlorinated and raw water supplies found HPC levels in drinking water to range between less than 200 to less than 1,000 colony forming units per milliliter (CFUs/ml).[3] (It should be noted that measurements of less than 500 CFUs/ml are normally considered acceptable.) A 23-fold increase in bacterial counts was measured with a decrease in chlorine residuals, while 10-to-1,000-fold increases were observed when turbidity exceeded 5 nephelometric turbidity units, or NTUs. The highest HPC densities were noted when temperatures approached 20°C (68°F) in late summer.

Effects of elevated HPC levels

An increase in bacterial counts may be noticeable by a change in the aesthetics of water. Taste, odor, color and corrosiveness may all be indicators of bacterial regrowth,[13] but there is much controversy over whether or not the presence of HPC bacteria constitutes a threat to public health. A study conducted by the University of Quebec monitored the rate of gastrointestinal illnesses among 2,400 people over 12 months, where under-the-sink reverse osmosis (RO) filtration units were installed in a random half of the study households.[5] The study concluded that drinkers of unfiltered tap water have a 30-to-35 percent higher chance of getting gastroenteritis compared to those who drank the filtered water—even though RO treatment is not disinfection it did reduce pathogenic contaminants and thus illnesses. The study tap water was estimated to be causing some 2,000 illnesses per year per 10,000 people.

Bacterial relationships

As mentioned, the majority of het-

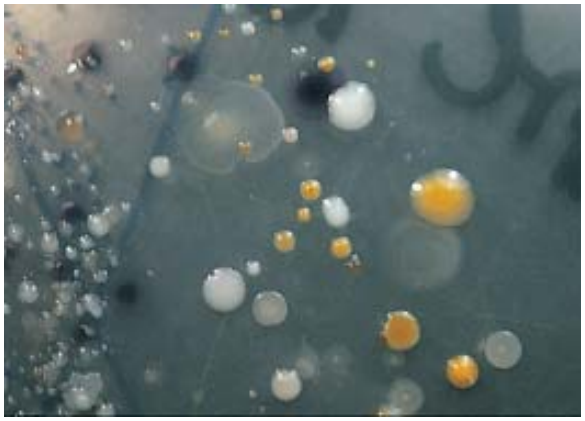

Figure 1. Heterotrophic bacteria

erotrophic bacteria in water are not pathogenic to humans. The 1980 study determined that less than 30 percent of the bacteria isolated in distribution water were opportunistic pathogens, meaning that they can cause disease in human immunocompromised populations.

On the other hand, the antagonistic effect of HPC organisms against other potentially pathogenic organisms has been suggested as a beneficial presence in drinking water.

Legionella inhibition

A 1986 study found that nearly half of the bacterial strains isolated from water samples were inhibiting the growth of *Legionella pneumophila*, the cause of Legionnaires' disease,[4] the organism responsible for the pneumonia-like, sometimes fatal ailment. More recently, researchers from the University of Queensland, Australia, discovered that 16-to-32 percent of HPC bacteria isolated from chlorinated drinking water inhibited the growth of *Legionella* species.[10] However, they also report that some HPC bacteria interacted positively with *Legionella* species and actually stimulated their growth. These variable responses may explain why some *Legionella* species are more prevalent in the environment than others; but for now the concern is that the presence of *Legionella* may be masked by HPC inhibition in laboratory growth media, leading to a false negative result when testing for its presence.

Coliform detection

Another 35 percent of the heterotrophic bacteria in the 1980 study were found to be harmful to coliform bacteria, having a potential for suppressing their growth—possibly by out-competing them for available nutrients. This effect does, at the very least, have an implication for determining the meaning of a quantitative coliform test being used to indicate overall water quality.

Currently, there is no U.S. Environmental Protection Agency standard for HPC levels in drinking water, although under 1989's Total Coliform Rule, HPC can be used as a secondary backup method to evaluate questionable coliform test results. Within this criteria and mentioned earlier, HPC levels of less than 500 CFU/ml constitute an acceptable result with regard to safe water quality.[11] Likewise, this same parameter indicates that disin