Microbiological Standards for Shellfish Growing Areas — What Do They Mean?

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ABSTRACT

Chemical pollutants and shellfish toxins are significant public health concerns in shellfish waters. However, the major concern, in classification of shellfish waters, is the presence of viable fecal material. Indicators of pollution are discussed and the coliform growing area standard and its proper utilization are described.

In reviewing recent literature concerned with isolation and identification of viruses from molluscan shellfish (oysters, clams and mussels), sediments and shellfish growing area waters, the research community in general appears to lack understanding of the shellfish growing area standards and criteria and how they are applied in the classification of shellfish growing area waters.

The purposes of this paper are (a) to briefly discuss bacterial indicator groups and the standards which utilize the two most significant members of the indicator groups, and (b) to explain the proper use of these standards as they apply to edible species of oysters, clams and mussels.

GROWING AREA CLASSIFICATION

Shellfish growing area classification studies may be divided into two parts, the sanitary survey and the bacteriological survey. The sanitary survey can be compared to the low power objective on a microscope; it provides an overall view of pollution sources, types and volumes of sewage. The bacteriological survey, on the other hand, is analogous to the high power objective. It defines the level of viable sewage organisms in terms of indicator equivalents at any given point in the estuary from the sewage outfall to that point where the indicator can no longer be detected because of dilution, dispersion or the biological and physical dynamics of the estuarine system under study. The indicator groups do not measure total sewage organisms. They measure only those organisms that meet the indicator criteria and have survived wastewater treatment processes and natural die-off. Pathogenic bacteria and viruses, the organisms of greatest public health concern, are among those organisms included in viable sewage that are not measured by the indicator. According to public health tradition, presence of viable sewage as determined by the indicator group is presumptive evidence of the presence of pathogens.

A limited number of shellfish areas in the U.S. have been closed to harvesters because of a variety of chemical contaminants such as mercury, kepone and petroleum products. Although areas in New England, Florida and the Pacific Coast may be intermittently or permanently closed because of shellfish toxins (1), the predominant cause of shellfish area closures is the continued use of the estuary as a repository for domestic sewage. Shellfish control agencies do not disregard the possible long-range health effects related to consumption of toxic chemicals in shellfish or the immediate health effects caused by shellfish poisons. However, the major health hazard potential related to shellfish consumption is the continuous or intermittent disposal of domestic wastes into the estuary via the sewer outfalls, the cloaca of our society's villages, towns and cities.

The presence of sewage in the estuary establishes a ground of contention between two opposing forces, the control agency responsible for food protection on one side, and the shellfish industry on the other (2). Both of these forces have legitimate positions. The shellfish industry seeks to utilize the maximum amount of the available resource without causing illness to its customers, whereas the control agency must assure that the shellfish beds are not exposed to hazardous or potentially hazardous levels of viable feces and other contaminating materials that could harm consumers.

THE CONTROL AGENCY

To fulfill its responsibilities, the shellfish control agency must have adequate means of detecting and measuring levels of sewage organisms in growing area waters. Although the agency realizes that a zero-tolerance goal is unachievable, it must also determine what level can be tolerated and still maintain both factors of product integrity — safety and quality.

Thus the control agencies conclude that the principal hazard to shellfish consumers is the presence of viable sewage in the growing area and that a pollution-free shellfish environment is inconsistent with the "multiple use" concept of estuaries. The agencies then face the challenge of determining the most effective means of detecting and measuring the hazard, and establishing shellfish growing area standards that will guarantee the public health integrity of shellfish harvested for the
consumer market. Because of the complexities of fresh shellfish marketing and processing practices, and the inability of control agencies to determine the degree of processing the product will receive before it reaches the consumer, the control agency must proceed as though the product will be consumed raw. The growing area standard, or level of sewage permitted in the "approved" growing area, must take this into account. Simply put, how much feces will the control agency and the public tolerate in waters that produce filter-feeding shellfish potentially destined for the raw market?

SANITARY QUALITY OF WATER

A variety of groups of bacteria and viruses have been used or recommended to indicate the sanitary quality of environmental waters. These range from a broad spectrum group such as the aerobic plate count to a narrow spectrum group such as Escherichia coli (2,5). Of these various groups the most commonly used are the coliform, fecal coliform and fecal streptococcus groups. Historically, the most common bacterial indicator group used by the public health community to determine the presence of sewage has been the coliform group. Improved methodology has resulted in the development of a fecal coliform growing area standard for shellfish waters (3). This group is considered to be a more specific indicator for direct fecal contamination and is now being used by some of the state shellfish control agencies.

The coliform standard for "approved" shellfish waters described in Part I of the Manual of Operations of the National Shellfish Sanitation Program (NSSP) (4) states that "The coliform median MPN of the water does not exceed 70 per 100 ml and not more than 10% of the samples ordinarily exceed an MPN of 230 per 100 ml for a 5-tube decimal dilution test (or 330 per 100 ml, where the 3-tube decimal dilution test is used) in those portions of the area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions." The upper 10 percentile limitations were included to account for the variability of the multiple tube fermentation procedure. It was not the intent of the NSSP that shellfish control agencies should permit an area to remain open if the levels of coliforms exceeded the 70-230 standard 10% of the time. Accordingly, "approved" sampling stations should qualify for both sections of the standard, the median MPN of 70, and the 90 percentile MPN of 230.

The question at this point is how the control agency relates the standard to levels of viable sewage. In more precise terms, how much viable fecal material is in water which contains a coliform MPN of 70/100 ml?

It is extremely difficult to relate coliform or fecal coliform values to levels of viable sewage when the elevated levels of indicator organisms are caused by land runoff or other non-point sources of pollution following rainfall. However, when the indicator organisms detected at a specific station can be traced to a point source such as a sewer outfall, the relationship of indicator level to specific volumes of sewage or coliform population equivalent can be determined.

The NSSP uses the value 160 x 10^8 as the per capita per day contribution of coliforms in municipal sewage. At this level, a single population equivalent of coliforms, or the coliform equivalent to the fecal material produced by one person in one day, would have to be diluted and dispersed in 8 million ft^3 of coliform-free water for that unit volume of water to meet the coliform growing area standard. In more graphic terms, 8 million ft^3 of dilution water would fill a tank with a bottom area the size of a football field to a depth of 177 ft or a cove a quarter of a square mile in an area to a depth of approximately 4 1/2 ft.

At first glance, the standard may appear to be excessively restrictive, but in view of the physical and biological dynamics of estuarine systems, the small size of the sample taken for monitoring purposes, the small number of samples taken per station per year and the wide range of values permitted by the standards, the 70 MPN coliform or 14 MPN fecal coliform standards are believed to represent a reasonable compromise between consumer protection and unreasonable restrictions on resource utilization. It should be emphasized that a 70 MPN median permits approximately 40% of the samples taken from a station to range between 70 and 230, and 10% of the samples to exceed 230. If water quality is monitored on a monthly basis, as is usually true, the level of viable sewage in sampling stations adjacent to the "approved" side of the closure line can exceed the 70 MPN to a considerable degree throughout the year and still meet the standard.

If there were a constant level of pathogens in sewage, a more definitive standard based upon pathogens such as salmonella or enteric viruses might be feasible, but the ratio between the indicator group and pathogens varies with every unit volume of sewage flowing from the outfall. A specific level of feces in wastewater may be relatively free of pathogens at one moment and have a high potential for pathogen transmission through shellfish a moment or so later. However, under optimum pathogen recovery conditions, the high cost of monitoring for pathogens would still have to be considered.

Because of the high costs of monitoring for pathogens, absence of a constant indicator/pathogen relationship, variation in numbers and types of pathogens in sewage, limitations of routine sampling practices and meteorological and hydrographic effects on the physical and biological dynamics of the estuary, the control agency has no reasonable alternative than to test for viable sewage when attempting to establish a shellfish closure line in an estuary.

Both the coliform and fecal coliform indicator groups have been used successfully in the classification of shellfish growing areas. Neither group fulfills all of the desirable characteristics of the ideal indicator. The standards are based upon the public health assumption that the presence of viable fecal material in estuarine

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