The AQUA-CHIP Project:

Development and validation of a DNA-chip technology for the assessment of the bacteriological quality of bathing and drinking water

Pathogenic bacteria are a major health concern in drinking and bathing waters. Present day assessments of bacterial contaminations rely on culture methods, i.e., plate counts of coliform bacteria, despite low reliability for detection of bacteria and their pathogenicity. It is our objective to develop molecular methods to identify and quantify pathogenic bacteria directly in any given water sample.

Objectives

The overall objective of the AQUA-CHIP project was to develop and validate a DNA-chip technology to assess rapidly and accurately potential human health risks arising from bacterial contamination in drinking and bathing waters.

This main objective can be divided in three parts:

- Develop molecular methods to identify and quantify the presence of important pathogenic and indicator bacteria in any given water sample and to assess their state of activity and pathogenicity;
- Compare laboratory and field data to assess health risks in aquatic environments and design a multiparametric assay based on molecular probes;
- Combine quantitative Polymerase Chain Reaction (PCR) and DNA-chip technology to validate a DNA-array suitable for mass application that leads to scientifically sound new procedures for the assessment of the hygienic quality of drinking and bathing water.

Key findings and conclusions

The following was achieved:

- A simple and robust procedure for extraction of environmental RNA/DNA from water samples suitable for mass application was developed;
- Primers and probes for housekeeping and pathogenicity genes of the targeted pathogenic and indicator bacteria were provided;
- DNA-chips for the assessment of waterborne bacterial pathogens were designed and validated;
- Molecular assessment of activity and abundance of pathogenic bacteria in water was made;
- The overall microbial community structure and composition of bathing and drinking water was assessed;
- Classical and molecular analyses for assessment of water-borne pathogens were compared;
- It could be shown with a variety of drinking and bathing water samples that each habitat had its own characteristic molecular fingerprint of the bacterial microflora with underlying seasonal variations. These community fingerprints could function as indicators of the quality of drinking water from the supplier to the end user. These molecular analyses demonstrated that the various treatment processes had a significant impact on the overall microbial community structure and composition of the drinking water microflora. On the other hand, the drinking water microflora was rather stable for several months at the tap end of the supply system. Therefore, community fingerprints and composition analyses could function as a new monitoring tool for the quality of drinking water from the supplier to the end user;
- The DNA-chip based technology for the detection of pathogenic and indicator bacteria in bathing and drinking water was tested and validated with a set of drinking and natural bathing water samples. This technology includes: i) a kit for the extraction of nucleic acids from water samples; ii) several DNA-chips for specific waterborne pathogens and indicators; and iii) a computer-based analytical systems that quantifies and identifies the response of the aquatic DNA on the chip;
- AQUA-CHIP detection technology as developed by Genolife, France (www.genolife.com).

Relevance and contribution to EU policy

The current detection technology is dependent on cultivation and is therefore rather slow and unreliable. It does no provide directly information about the taxonomic position of the detected organism. The technology developed is faster, more reliable and provide taxonomic information about the detected bacteria. It is open to automation and mass application. Potential end users are public health authorities, water authorities, drinking water industries and tourism information systems.

The results of the AQUA-CHIP project will not only help controlling the bacteriological quality of drinking and bathing water but will also stimulate the use of molecular techniques for the monitoring of environmental quality in Europe. We anticipate that our results will also lead to high-throughput methods that allow routine use and will become available to SMEs working in environmental control. This will lead to the development of technology for industrial use, foster the use of environmentally friendly biological techniques and generally support the use of new molecular methods to monitor biological risks.

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