

APTAVIR

Design of an innovative diagnostic test for the in-situ detection and quantification of food- and waterborne viruses based on the aptamer technology.



Inspiration

The risk of viral epidemics and pandemics has undeniably increased in recent decades due to global changes in interconnectedness, climate and the human-animal interface. The emergence of new diseases such as Covid-19 remind us that human, animal and ecosystem health are interconnected and that a greater focus on the human-animal-environment interface is needed to strengthen the global public health. This is particularly true for food- and water-borne viral diseases, where climate change and human growth and activities affect water resources in a variety of direct and indirect ways, and increase human exposure to water-related contaminants.

Water- and food-borne transmission is a common mode of spread for a wide range of viruses responsible for gastroenteritis (norovirus, sapovirus, astrovirus, rotavirus and adenovirus) and hepatitis (hepatitis A and E viruses), following exposure to contaminated food and water. Despite their importance to public health, surveillance programmes for these viruses in the food chain and in the aquatic environment are very limited. For example, shellfish, known to be a major source of gastroenteritis outbreaks, must only be tested for faecal indicator bacteria to comply with EU food safety regulations, even though pathogenic viruses may be present.

In order to detect outbreaks of food- and waterborne viral diseases and to prevent underestimation of the disease burden and its insidious spread, it is essential to improve current environmental, food and medical surveillance systems. There is therefore a growing demand for rapid and reliable diagnostic technologies, in particular methods capable of detecting pathogens in situ and operating under difficult conditions, prompting researchers to explore new and alternative avenues of development and innovation.

Innovation

The main objective of the APTAVIR project is to develop an innovative detection tool based on DNA aptamers for monitoring the main foodborne viruses in the environmental, water, food or clinical samples.

But what are aptamers? These are short, single-stranded nucleic acids (DNA or RNA) that can bind specifically to a specific target, including proteins, small molecules, toxins and even live cells. Their remarkable specificity and affinity for their target make aptamers a promising technology for diagnostic and therapeutic purposes. However, despite their many advantages, aptamers have not been widely used as diagnostic tools to date. More conventional methods, such as amplification and detection of genetic material or the use of antibodies, are still widely used, leaving open the possibility of developing an innovative alternative technology based on aptamers.

Because of aptamer extraordinary potential, we, at LIST, started to look closely at these nanoscopic molecules for the fast and accurate detection and quantification of pathogenic viral particles. We were the first to design aptamers targeting adenoviruses and to validate their efficacy on a laboratory scale, resulting in a patent (WO2020/126434A1). Our innovative solution, as promising as it is, is still in the early stages of development. Several scientific and technical gaps and R&D challenges still need to be addressed to provide a ready-to-use diagnostic kit with aptamers as the core technology. The design of new aptamers, the generation of a multiplex test for the detection of viral targets, or the capability of aptamer technology to work properly in complex samples such as dirty environmental samples are among the major challenges to overcome. It is through APTAVIR project that we aim to fill these gaps and meet these hard tasks.

Impact

The key deliverable of the APTAVIR project is the design of a rapid, reliable and multiplex diagnostic test for a specific panel of foodborne viruses, based on aptamer technology, the so-called aptasensors.

To achieve this goal, we are going to continue the characterization of DNA aptamer candidates for adenovirus and, for the first time, design, customise and optimise new aptamers for the other major groups of foodborne viruses, namely norovirus, sapovirus, astrovirus and rotavirus. In addition to these main viruses responsible for gastroenteritis, hepatitis E and A viruses will be included in our selection as emerging or new foodborne viruses. The choice of viral groups to target was motivated by their importance for public health, as well as our own expertise in the study of food- and waterborne viruses.

The technological solution that could emerge from the APTAVIR research project could improve microbial quality assessment activities in the food and water industries, as well as in clinical diagnostics. In addition, such a tool could be extended to other emerging human-animal interface pathogenic viruses that are also of global concern today. If LIST succeeds in participating in the launch of the first diagnostic kit for foodborne viruses using aptamers at the international level, the positive impact of such an achievement would definitely put the spotlight not only on LIST, but more widely on Luxembourg's innovative skills in virological detection.

Partners

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