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(Review Article)

Foodborne virus-based: Cellular tropism and rapid methods of detection for food surveillance

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Abstract

There are a wide range of microorganisms and chemicals risks that can cause illnesses resulting from the ingestion of foods of viral origin. Viruses cannot multiply in foods; however, foods serve as vehicles for infections. Foodborne diseases commonly address cellular tropism by the interaction of a viral surface protein with a host receptor reaching several organs and/or tecids classified by neurotropic (inducing central nervous system disorders), hepatotropic, enterotropic, pneumotropic and multitrophic for example Human adenoviruses (HAdVs), Noroviruses (NoVs), Hepatitis A virus (HAV), Hepatitis E virus (HEV), Parvoviruses, Rotaviruses (RVs), Caliciviruses, Polioviruses and others. Foodborne virus-based illness may be transmitted through eating food contamination linked diseases transmission sources as use inadequate hygiene of food, lack of basic sanitation, poor personal hygiene and consumption of raw or undercooked food. This paper described the rapid methods of detection in safety microbiology as cell culture-based, immunoassay and molecular-based technologies. Nanotechnology and food conservation has grown exponentially with investments in nanocompounds to produce antimicrobial materials for “smart” food contact surfaces. The implementation of molecular-based tools and viral tropism studies to high-throughput for foodborne issues should be up to date to mitigate the risk on environments virology and to avoid the risk in food safety and the impact on one health. Strategies of prevention of foodborne viruses-based has been implemented in surveillance programs for food microbiology.

Keywords: Environments virology; Food safety; Methods detection; Foodborne diseases; One health

1 Introduction

There are a wide range of microorganisms and chemicals risks that can cause illnesses resulting from the ingestion of foods of viral origin. Viruses cannot multiply in foods; however, foods serve as vehicles for infections. Gastroenteritis of non-bacterial origin and caused by numerous viruses has been demonstrated since the first discoveries of norovirus (formerly known as Norwalk virus), in 1972, and rotavirus in 1973. Some examples of viral microorganisms involved in foodborne diseases: Hepatitis A with a 3 to 60 days of incubation period and 2 to 4 weeks of illness duration; Norovirus and Rotavirus present in 24 to 48 hours and 24 to 72 hours respectively related to the incubation period and 1 to 2 days and 4 to 6 days, respectively, characterizing the duration of food infections attributed to these viruses [1].

Among the physical characteristics and biochemical properties, it is important to highlight that foodborne viral pathogens vary in size from 15 to 400 nm; foodborne viruses are quite stable outside the host and resistant to acids;

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and large amounts of viral particles are excreted in the feces of people infected (up to 10^{11} particles/g of feces has been reported for rotavirus). Consequently, untreated sewage can have 10^3 to 10^5 infectious particles/L [1].

Foodborne illness surveillance involves collecting, analyzing, and monitoring trends in foodborne pathogens. In terms of food security, it is essential that surveillance systems follow the obligations of the International Health Regulations – IHR 2005 and International Food Safety Authority Network (INFOSAN). The Foodborne Disease Active Surveillance Network – FoodNet founded in the United States works together with the Center's Emerging Infections Program – EIP for Disease Control and Prevention – CDC in collaboration with Food Safety and Inspection Service – FSIS of the Food and Drug Administration (FDA) [1].

European Center for Disease Prevention and Control – ECDC (URL: http://ecdc.europa.eu) is an international surveillance network for human gastrointestinal infections including antimicrobial resistance [1].

Food preservation methods which are commonly used are heating, chilling, freezing, acidification, drying, and packaging [2]. The Food-borne viruses in Europe network, involving several countries, was established with the purpose (Eurosurveillance 2002, http://www.Eufoodborneviruses.co.uk) of standardizing molecular typing, electrical microscopy and serotyping methods [1]. Some viral pathogens which may be transmitted by ingestion of contaminated food such as Hepatitis A (HAV), Hepatitis E (HEV) viruses and enteric viruses including adenovirus, astrovirus, rotavirus, calicivirus, Norwalk and other Small round structured viruses (SRSV) had been reported in food outbreaks [3,4].

Outbreaks of gastroenteritis caused by the food- and waterborne viruses can be transmitted by routes: (i) shellfish contaminated by marine waters polluted by fecal materials, (ii) contamination of drinking and irrigation water with human sewage or sewage-polluted recreational waters; (iii) contamination of ready-to-eat or prepared-for-eat foods as a result of poor personal hygiene by food handlers who are infected; (iv) production of aerosols from vomit and (v) through contact with contaminated surfaces [5]. Human adenoviruses (HAdV) and animal adenoviruses linked viral tropism and clinical manifestations which the virus is excreted through the pharynx and feces inducing diarrhea and vomiting as signals clinicals of the disease have already been reported [figure 1]. Several animal species such as bovine and pig's disorders or lesions in central nervous, respiratory, reproduction and gastro system also had been documented by enteroviruses as animals' pathogens [5].

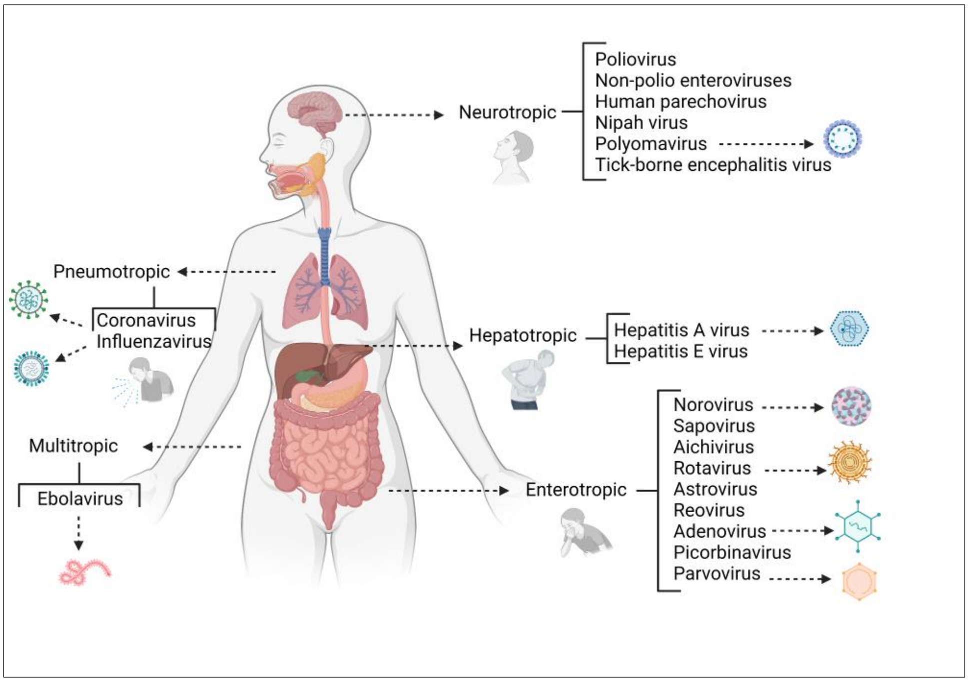

Figure 1 Foodborne viruses inducing cellular tropism by the interaction of a viral surface protein with a host receptor reaching several organs and/or tecids classified by neurotropic (inducing central nervous system disorders), hepatotropic, enterotropic, pneumotropic and multitrophic for example Human adenoviruses (HAdVs), Noroviruses (NoVs), Hepatitis A virus (HAV), Hepatitis E virus (HEV), Parvoviruses, Rotaviruses (RVs), Caliciviruses, Polioviruses and others. (Adapted of M. Koopmans). This figure was created and designed by the author using scientific image and illustration software with publication license into journals

Filter-feeding mollusks and ingredients used for salad are the foods most frequently implicated in outbreaks involving norovirus [1]. Food or contaminated environments (e.g. via washed fruits) can be source of transmission of Norwalk-like viruses (NLV) which had been detected by ELISA based assays and different genotypes of NLV cocirculate can be monitored by molecular epidemiology studies [6].

Hepatitis A virus (HAV) is associated with the greatest risk of foodborne transmission by contact direct from person to person, or indirectly via food, water, or fomites contaminated with virus-containing feces or vomit [6]. HAV reflects in high number the new cases usually associated with the levels environmental both sanitary and hygienic including poor socioeconomic conditions [6, 7].

The risk of microbiological contamination by the presence of viruses in crustaceans is very relevant for food safety causing gastro-enteritis outbreaks [10]. Human norovirus (HuNoV) causes of foodborne disease outbreaks. HuNoV has also been investigated in leafy greens and fresh herbs demonstrating a good correlation between murine norovirus (MNV) and HuNoV [10]. Hepatitis A viral (HAV) RNA was detected in only one of the 392 mussel samples analyzed and in none of the 228 oyster samples investigated [10].

Most recent reported occurrences in different countries on several continents had been documented according to tracking of variants [11]. Classical and Next-Generation Biotechnological platforms for SARS-CoV-2 vaccine candidates licensed and Real-time tracking of SARS-CoV-2 evolution had been constantly monitored by epidemiological surveillance applied metagenomic tools [11].

The most effective methods to evaluate their ability to eliminate or reduce the coronavirus infection may be about the thermal processing as main way for inactive SARS-CoVs heating at 75°C (15– 60 min) to reduce the viral load [2]. Cell culture-based methods may be able to estimate the levels of concentrations of some viruses. For another hand, molecular methods such as Reverse Transcription (RT-PCR) are useful for detection of enteric viruses (Figure 2). Viral mRNA targeting assay and integrated cell culture polymerase chain reaction (ICC-PCR) used to detect both DNA viruses and RNA viruses (ICC/RT-PCR) quantifications methods of enteroviruses serotypes detect in several transmission sources like sewage [7, 8, 9].

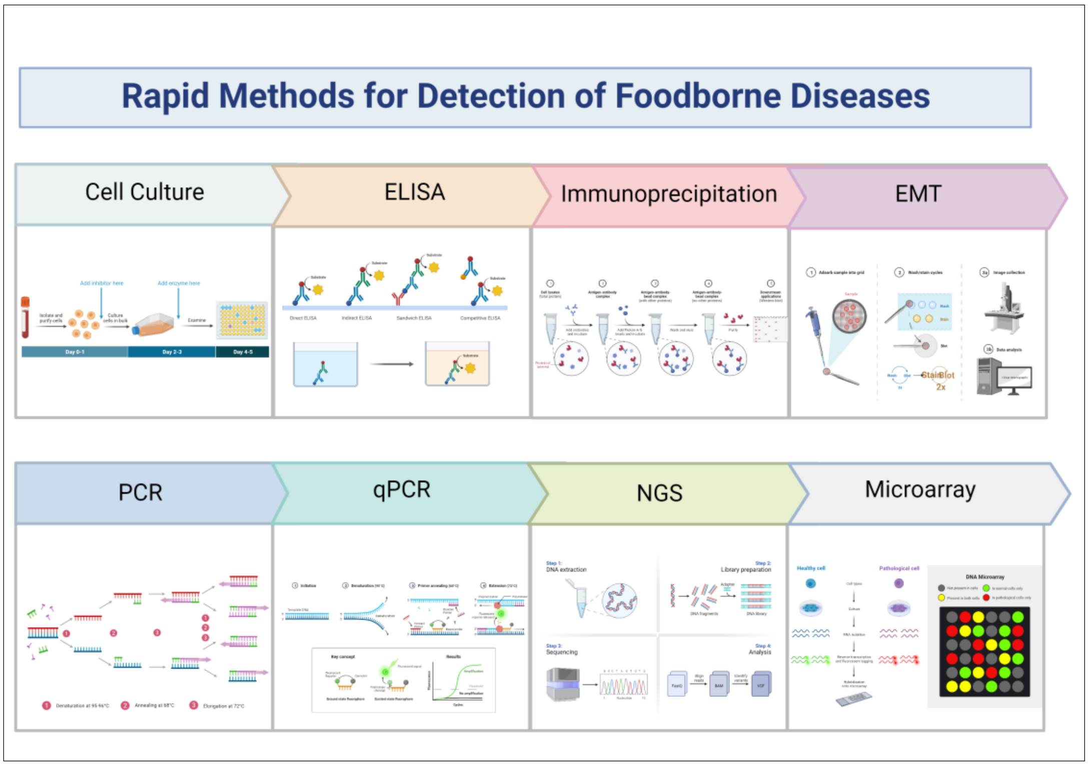

Figure 2 Viruses for food safety detected by rapid methods classified in classical assays (cell culture; Elisa; immunoprecipitation, Electron Microscopy Transmission (EMT) and molecular (PCR, qPCR, NGS and Microarray). This figure was created and designed by the author using scientific image and illustration software with publication license into journals

Methods for waterborne diseases for Virus Concentration as

- Electro positive/negative filters;
- Glass filters;
- Vortex flow filtration – VFF;
- Tangential flow filtration – TFF.

Classical Detection as

- Plaque forming;
- Radioimmunoassay;
- Immunofluorescence;
- Enzyme-linked immunosorbent assay – ELISA.

Molecular Detection as

- PCR/RT-PCR/qPCR;
- Microarray;
- Atomic Force Microscope – AFM;
- Biosensors had been described [7].

NASBA methods are used for RNA detection using three enzymes: T7 RNA polymerase, Reverse transcriptase and RNase H [6,7]. Recently NGS sequencing (ChIP-Seq) analysis applied for detection methods of waterborne viruses [8,9,12].

2 Considerations

Nanotechnology and food conservation has grown exponentially with investments in nanocompounds to produce antimicrobial materials for "smart" food contact surfaces that can detect contamination and inhibit the multiplication of food pathogens, as well as remove contamination and possible odors to prolong the life of food on the shelves. These materials come from nanoparticles of ingredients in macroscale previously approved to avoid potential health risks [1]. Outbreaks of foodborne infections should be monitoring by surveillance system using clinical-epidemiological and virological methods for detection foodborne viruses. It supports the relevance of food-based epidemiology monitoring of viral contamination and adopted prophylactic measures in order to mitigating the environmental risks [12].

3 Conclusion

Foodborne diseases commonly address cellular tropism by the interaction of a viral surface protein with a host receptor reaching several organs and/or tecids classified by neurotropic (inducing central nervous system disorders), hepatotropic, enterotropic, pneumotropic and multitrophic for example Human adenoviruses (HAdVs), Noroviruses (NoVs), Hepatitis A virus (HAV), Hepatitis E virus (HEV), Parvoviruses, Rotaviruses (RVs), Caliciviruses, Polioviruses and others. So, the author suggests that, regardless of viral tropism, molecular interactions may also occur between different viral families that amplify the action of viruses and enhance clinical symptoms, such as cross-reactions in the inappropriate handling of food and its storage. Therefore, the implementation molecular-based tools to high throughput for environmental systems should be up to date to avoid the risk and impact on one health and surveillance programs of genomic.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest.

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