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Transmission of common foodborne viruses by meat products

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Abstract

The most common foodborne viruses are single stranded RNA viruses which are adaptable and extremely resistant to environmental stress factors. Usual routes of food contamination are via stool material by persons shedding intestinal virus, or by saliva aerosols generated by shedding persons when coughing. Contamination of meat by animal viruses occurs when good hygienic and manufacturing practice fails. Once within food, viruses cannot replicate since they require living cells for this; hence food is not sensorily altered. Preventive measures in meat processing against pathogenic bacteria frequently have poor antiviral performance, while diagnostic techniques for viruses remain problematic.

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1. Introduction

Viruses are extremely small microorganisms, ranging in size from 20 to 400 nm. They have a simple structure made up of the viral RNA or DNA, surrounded by a protein coat and, in some viruses, a lipid envelope around the protein coat. Unlike bacteria, viruses are not free-living microorganisms and only replicate within the living cells of humans, animals, plants or bacteria. Viruses do not infect hosts at random; they rather have tropism towards specific

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group of cells and/or hosts. Once they invade cells, they take control over the cell metabolism and redirect it to synthesize more viral proteins and nucleic acids by utilizing cellular enzymes. Viral contamination of food occurs either as clinical contamination or as environmental contamination. In the case of clinical contamination, the virus replicates within an animal, products from which are then consumed without the virus being inactivated. This is fairly uncommon and there were just a few cases of viral infection of this type reported (tick-borne encephalitis in ruminant's milk)[1,2]. The most common route of viral food contamination is environmental contamination. This frequently involves direct contamination of food during handling by drops created when an infected person coughs or by contamination with stool material from a person infected with an intestinal virus. Environmental contamination occurs due to sewage coming in contact with water used for growing bivalve molluscs or in the production of fresh produce.

2. Characteristics of foodborne viral infection

Foodborne viral infection causes rather explosive outbreaks. Infective doses are extremely low i.e. only a few viral infectious particles (less than 100) are needed to cause infection and subsequent illness. Infected persons shed viral particles in stool and vomit, a peak level of 10^7-10^{10} viral copies per gram of feces. Although illness lasts only a day or two, shedding of virus can continue for up to 60 days[3]. Viruses do not replicate in food under any temperature and/or water activity since they require living cells to replicate. Hence they do not induce alterations of food ingredients and subsequently food smells, looks and tastes normal. However, due to lack of physiological activity they can persist for extended periods in conditions which can otherwise inactivate common foodborne pathogenic bacteria.

The most common foodborne viruses and their characteristics are presented in Table 1.

Table 1. Common foodborne viruses and their characteristics.

Virus/Family	Genome	Type of illness	Source	Transmission/ Food vehicle	Risk level
Norovirus/*Caliciviridae*	ss RNA	Gastroenteritis	Human stool, vomit	Fecal-oral/berry fruit, deli meat, shellfish	High
Hepatovirus A/*Picornaviridae*	ss RNA	Hepatitis A	Human stool	Fecal-oral and person-to-person/deli meat, raw beef, water, shellfish, fruit and vegetable	High
Orthohepevirus A/*Hepevirida*e	ss RNA	Hepatitis E	Pig liver	Environmental/Pork	Low to moderate

Except for Rotavirus, the likelihood of other human enteric viruses such as Adenovirus, Sapovirus, Aichivirus, Parvovirus and Poliovirus causing foodborne diseases is quite low due to their person-to-person transmission routes, so risk level should be considered low.

3. Virus transmission by meat

3.1. Raw meat

Retrospective studies on transmission routes by raw meat are sparse. To date, Orthohepevirus A (hepatitis E virus – HEV) genotypes 3 and 4 have been frequently found in intestinal tract of European pigs and boars (prevalence 6% to 85%)[4] and has been confirmed in raw pork. It is not known at what stage of slaughtering virus contaminates raw meat; however, being shed via animal feces and urine and not efficiently spread from human-to-human it has been assumed that poor evisceration practice (loosened, tied off rectum, cut bladder, punctured viscera) is the main causes of meat contamination. Food handlers should also bear in mind that pig liver is also main source of contamination due to HEV tropism toward hepatocytes.