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Wissensgrundlagen

RISK PROFILES OF FOOD-BORNE PATHOGENS
HEPATITIS E VIRUS (HEV)

Hepatitis E is a growing concern due to its potential for severe health outcomes and its link to contaminated food products, particularly undercooked pork, wild game meat, and shellfish. The disease, which causes liver inflammation and can lead to acute liver failure in severe cases, poses the greatest risk to pregnant women and immunocompromised individuals. Robust safety measures, such as thorough cooking and stringent hygiene practices along the food production chain are essential to reduce the risk of contamination and ensure food safety compliance.

Hazard Identification

Types and Strains: The Hepatitis E Virus (HEV) is an RNA virus with distinct genotypes that vary in their host range and transmission dynamics. Four major human pathogen genotypes (GT 1-4) have been detected in humans and animals. One common serotype has been identified for these 4 GT. Further less common Genotypes include genotypes 5 and 6 which were found in wild boar, as well as genotype 7 and 8 occurring mainly in camels in South-East Asia and the Middle East. The following Table 1 outlines key properties of HEV.

Table 1: Characteristics of the virus

Characteristics of the virus	
Family/Genus	Hepeviridae/*Orthohepevirus*
Envelopment	Non-enveloped in the environment Quasi-enveloped in the bloodstream
Genome-Type	Single-stranded positive-sense RNA (ssRNA(+))
Size	7.5 kb
Diameter	30-34 nm
Main Genotypes (GT)	GT 1 and 2: exclusively in humans. GT 3 and 4: in human and animal populations (pigs, wildboar, deer). GT3 is the predominant genotype in Switzerland.
Replication	Mainly within liver cells of host species. No replication in the environment.

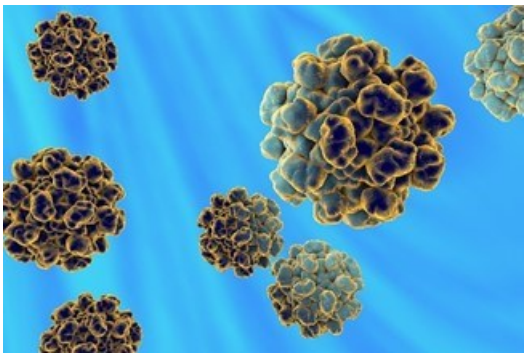

Figure 1: Illustration of the Hepatitis E virus

Stability and inactivation: HEV is highly persistent in the environment. It is as well highly persistent to salt and pH values that are commonly occurring during the processing of meat and meat products. Also drying only leads to little inactivation of HEV. Further details on inactivation and stability of HEV are available in Table 2.

Table 2: Inactivation and Stability of Hepatitis E Virus

Stability and Inactivation	
Heat	An experimental study using intravenous inoculation of pigs determined that inactivation required a core temperature of **71°C for 20 min** [1]. A more recent study based on cell cultures conducted by the Bundesamt für Risikobewertung (BfR) demonstrated that inactivation occurred at achieving a core temperature of **70°C for 2 min** (>4 $\log_{10}$ reduction) [2].
Salt	No effective inactivation.
pH	Very stable, inactivation at pH1 or pH10[3].
Drying	No effective inactivation [3].
Persistence	Highly persistent in the environment, with only low reduction rates above temperatures of 4°C.

	On inoculated stainless-steel discs infectious HEV particles could be recovered for up to 80 days, which corresponds to an estimated decay time of 5.95 days[4]. The virus survives gastric and intestinal tract conditions (i.e. acidic and mild alkaline pH) before being shed in feces, therefore it is likely to be relatively stable in sewage and water.
Disinfection	Soley alcohol-based disinfectants do not eliminate HEV. Disinfectants based on aldehyde, peracetic acid, oxygen, and/or quaternary ammonium inactivated HEV [5], [6]. UV treatments are effective at disinfecting contaminated water sources.

In an experimental study [7], a solution containing 2% sodium chloride with 0.015% sodium nitrite led to only a minor reduction in infectivity (<1 $\log_{10}$) after 2 and 4 days compared to Phosphate Buffered Saline (PBS). Similarly, a solution with 2% sodium chloride and 0.03% sodium nitrate showed a slight but statistically insignificant decline in infectivity after 2 and 8 weeks relative to PBS.

Hazard Characterisation

Disease Characteristics: The Hepatitis E virus affects the liver and can lead to inflammation and liver damage. While many infections cause no symptoms, some individuals may experience illness of varying severity. The disease is usually self-limiting, but in certain cases, it can become more severe. Some groups are at higher risk of complications. The Table 3 below provides an overview of key characteristics of Hepatitis E disease in humans, including its progression, symptoms, and affected populations. For more details see websites of the FOPH.

Table 3: Disease Characteristics

Disease Characteristics	
Incubation Period	40 days (9-60 days)
Mode of actions	HEV targets liver cells (hepatocytes), causing inflammation and potentially significant liver damage.
Symptoms	The majority of infections are asymptomatic. Most common symptoms: Jaundice, fever, fatigue, nausea, vomiting, anorexia and abdominal pain.
Progression	Mostly self-limiting within 2-6 weeks. In rare cases it can progress to fulminant hepatitis, a severe form of liver failure.
Infectious period (shedding)	4-6 weeks; 3-6 months in chronic cases.
Shedders	Shedders of HEV may be asymptomatic and shed the virus over several weeks.
Vulnerable populations	Pregnant women, at higher risk of severe outcomes (Lethality in 3rd trimester 10-40%) Individuals with pre-existing chronic liver disease, at higher risk of severe outcomes. Immunocompromised individuals, at higher risk of persistent infection and chronic disease.
Dose-Response Relationship	No standardized dose-response relationships for HEV have yet been established. An oral ingestion study in pigs has estimated a probability of infection of 50% at approximately 1.4 x 10^6 HEV genomic copies (PI50) [8]. Due to species differences, direct extrapolation to humans is not possible.
Prophylaxis	No vaccine is currently available against HEV.

Occurrence: Hepatitis E is a significant public health concern globally, with an estimated 20 million infections and approximately 3.3 million symptomatic cases annually. Details on the epidemiological situation in Switzerland are outlined in Table 4.

Table 4: Epidemiological Situation in Switzerland

Epidemiological Situation in Switzerland	
Annual reported cases	2018 to 2024: Annual reported cases between 70 and 111 (Infectious Diseases Dashboard (IDD) of the Federal Office of Public Health). An exception was the year 2021, when due to an outbreak 165 cases were recorded.
Mandatory reportable disease	Yes

Exposure Assessment

Transmission: HEV genotypes 1 and 2 are primarily transmitted via the fecal-oral route, often through contaminated food or water in regions with poor sanitation. In industrialized countries, genotypes 3 and 4 are increasingly recognized as foodborne pathogens, with transmission occurring mainly through the consumption of contaminated pork, wild game, or shellfish. Genotype 3 is the predominant strain in Switzerland, where undercooked pork and wild boar meat are the most common sources of infection.

Sources and Reservoirs: Pig farms are a significant reservoir of the HEV. The virus can be detected in pig feces and blood for extended periods, remaining consistently present

for over two months following infection. The seropositivity rate of nearly 60 % among pigs [9] shows that Hepatitis E is circulating in Swiss pig farms.

Outbreaks: The most significant recent outbreak occurred in 2021, with 168 recorded cases over the course of a year. Among the foods notably consumed more frequently by the cases were Lyoner, Mortadella, Cervelat, as well as pâté with pork (OR 2.36, 95% Confidence Interval [CI]: 1.08–5.16) and minced pork (OR 1.54, 95% CI: 0.79–3.02). Of 47 samples of fresh meat, two (4.3%) pig livers were HEV PCR positive; of 152 types of sausages, three (2%) cooked sausages (two liver sausages with mushrooms and one spreadable liver sausage) were HEV PCR positive. Due to technical reasons, sequences from humans and food products could not be compared and thus no specific food product could be identified as the cause of the outbreak [10]. However, it was demonstrated that the infections were caused by an HEV subtype prevalent in the Swiss pig population.

Inactivation of HEV in raw sausages of large calibers: An experimental cooking study by Agroscope examined whether sausages of large calibers, such as Saucisse au foie, reach a core temperature of 71°C when starting the simmering process in cold water (Agroscope, unpublished data).

Time required to reach a core temperature of 71°C:

- 28–33 minutes for calibers 38–42 mm
- 59–76 minutes for caliber 55 mm

Consumer instructions typically recommend simmering at 75–80°C for 45–50 minutes. However, the study indicates that depending on the initial water temperature and sausage size, these guidelines may not always ensure the desired core temperature is reached within the recommended cooking time.

Potential other sources: Recently, studies performed in Italy and the Czech Republic [11], [12] have detected HEV RNA in the milk of small ruminants. There is also evidence that HEV may survive the standard pasteurization processes[13], suggesting that milk or milk products derived from sheep or goat milk could also be a source of infection. However, this potential transmission pathway requires further investigation.

Details on sources and transmission routes in Switzerland, particularly those related to the predominant GT 3 and 4, are outlined inTable 5.

Table 5: Main Sources and Transmission Routes in Switzerland (GT 3 and 4)

Main Sources and Transmission Routes in Switzerland (GT 3 and 4)	
Main Reservoir	Pigs, wild boar, deer, elk sheep, cattle, rabbits. They are possible sources of zoonotic infections of humans [14]
Seroprevalence in pigs	58.6% (±22.0%) (n=192) [9] 58.1% (n=2'001) [16]
Transmission	Most common: food-borne Rare: Blood transfusions
Main source of infection	Consumption of raw or undercooked pork or wild boar meat Asymptomatic shedders are another important source of infection, particularly in food handling operations.
High risk food items	Consumption of raw pig, wild boar and deer meat products in particular products containing raw pork liver such as Saucisse au foie or Mortadella cruda [15, 17]Some studies also reported shellfish [18] as vehicles potentially implicated in foodborne transmission of HEV.
Secondary spread	Reported among household members during outbreaks.
Populations at elevated risk for infection	Consumers of raw or undercooked pork and wild game meat or meat products. Veterinarians, farmers, hunters, and slaughterhouse workers in close contact with infected animals.
Major Outbreaks	2021: 165 registered cases. No specific food source could be identified, but amongst cases, Lyoner, Mortadella, Cervelat, as well as pâté with pork and minced pork were consumed more frequently [10].

Regulatory Aspects

Regulation: While general food hygiene regulations apply to all food production and handling processes to minimize contamination risks, there are currently no specific Food Safety Criteria established for foodborne viruses, including HEV, in the EU and in Switzerland.

Detection: There is currently no standardized method for detecting HEV in foodstuffs, though the development of ISO-protocols is in development. Furthermore, the presence of viral RNA doesn't necessarily indicate infectious virus particles. In an experimental study on HEV-3, no correlation between the decrease of infectivity and the amount of RNA was found during the manufacturing salami-like raw pork sausages [2].

RESOURCES

- Website of the Federal Food Safety and Veterinary Office: https://www.blv.admin.ch/blv/en/home/lebensmittel-und-ernaehrung.html
- Infectious Diseases Dashboard (IDD) of the Federal Office of Public Health: https://www.idd.bag.admin.ch/

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