

Agents and outbreaks II

- viruses -**
- toxin producing and spore forming bacteria -**

Presentation 7
BTSF FBO course

Enne de Boer

Contents

- Viruses
 - Norovirus
 - Hepatitis A
- Toxin-producing sporeforming bacteria
 - *Bacillus cereus*
 - *Clostridium perfringens*
 - *Clostridium botulinum*
- Toxin-producing non-sporeforming bacteria
 - *Staphylococcus aureus*

Foodborne viruses

Different diseases may be caused by foodborne viruses:

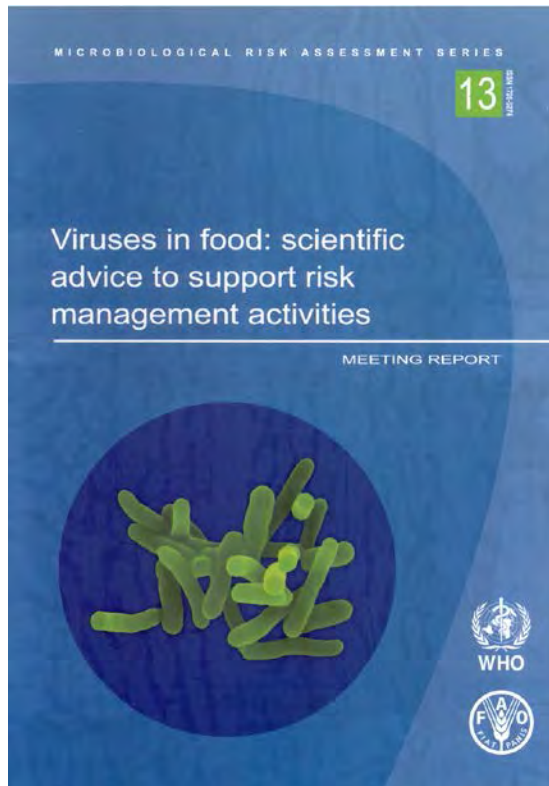
- gastro-enteritis – caused by astrovirus, rotavirus, adenovirus, caliciviruses (norovirus, sapovirus)
- hepatitis – caused by hepatitis A and hepatitis E virus
- illnesses affecting other parts of the body (poliomyelitis, meningitis, respiratory diseases, etc.) – caused by e.g. enteroviruses



Foodborne viruses - characteristics

- Transmission routes:
person-to-person, food,
water, surfaces
- Do not replicate in food, no
organoleptic effects
- Inf. dose: <100 particles
- Shedding: in stool ($>10^6/\text{g}$)
or in vomit
- Asymptomatic infections
occur. Shedding with or
without symptoms
- Can persist for months in
food/environment
- More resistant than bacteria
to control measures
- Freeze/refrigeration:
preserve viruses
- Heat/drying: differences in
resistance between viruses
- Hand-washing > sanitizers
- Effectiveness disinfectants
limited

Foodborne viruses



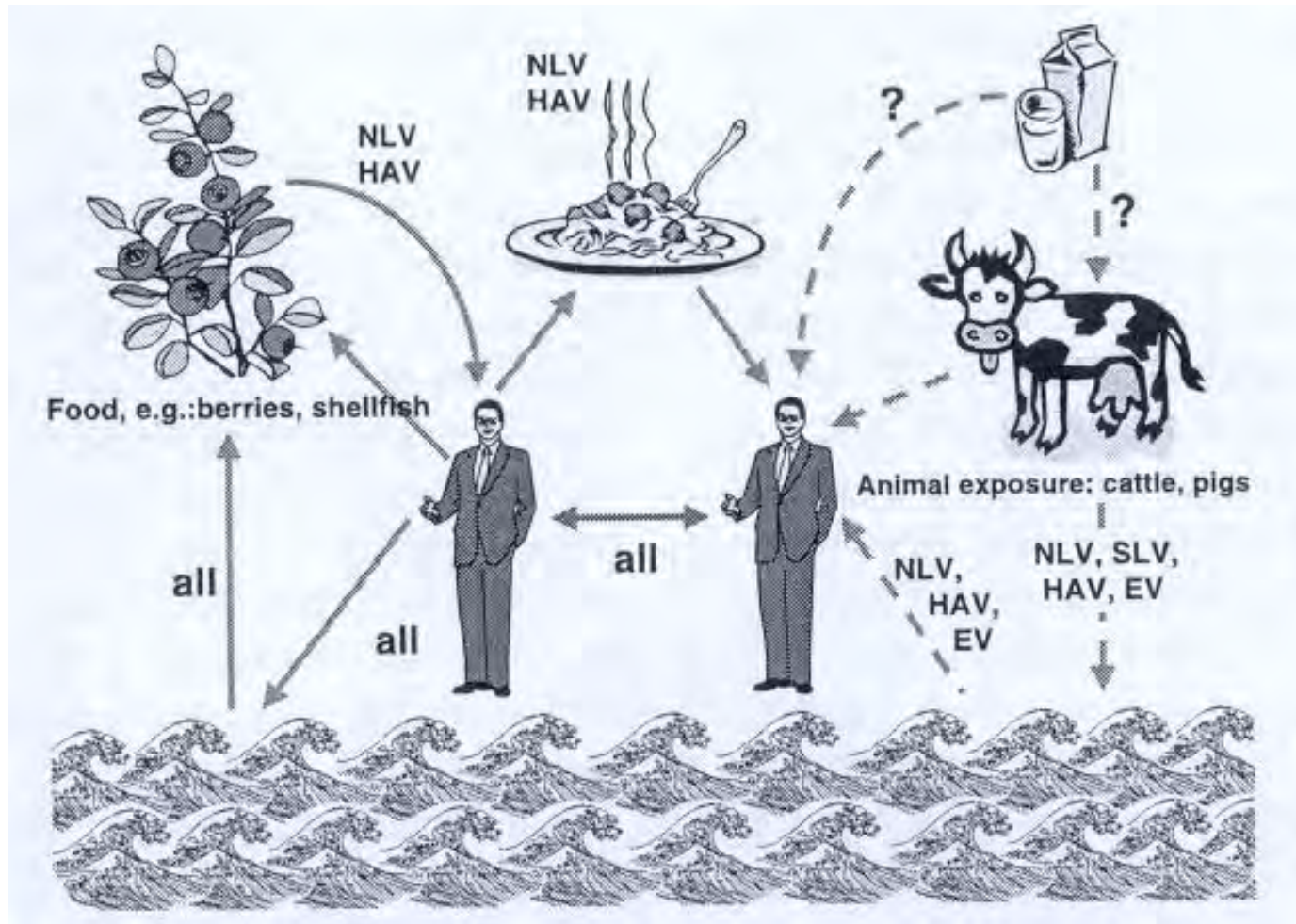
Codex Alimentarius
GUIDELINES ON THE APPLICATION
OF GENERAL PRINCIPLES OF FOOD
HYGIENE TO THE CONTROL OF
VIRUSES IN FOOD

CAC/GL 79-2012

**norovirus and hepatitis A virus are
currently recognized as the most
important human foodborne viruses**

http://www.who.int/foodsafety/publications/micro/Viruses_in_food_MRA.pdf

Transmission of enteric viruses



Foodborne viruses - norovirus

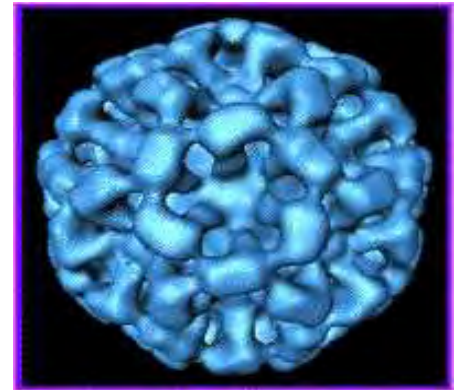
Norovirus (“Norwalk-like viruses”, SRSVs)

- relatively mild gastroenteritis
- incubation period 15 h -3 days; duration 1-3 days
- most common cause of gastroenteritis in outbreaks in the Western world



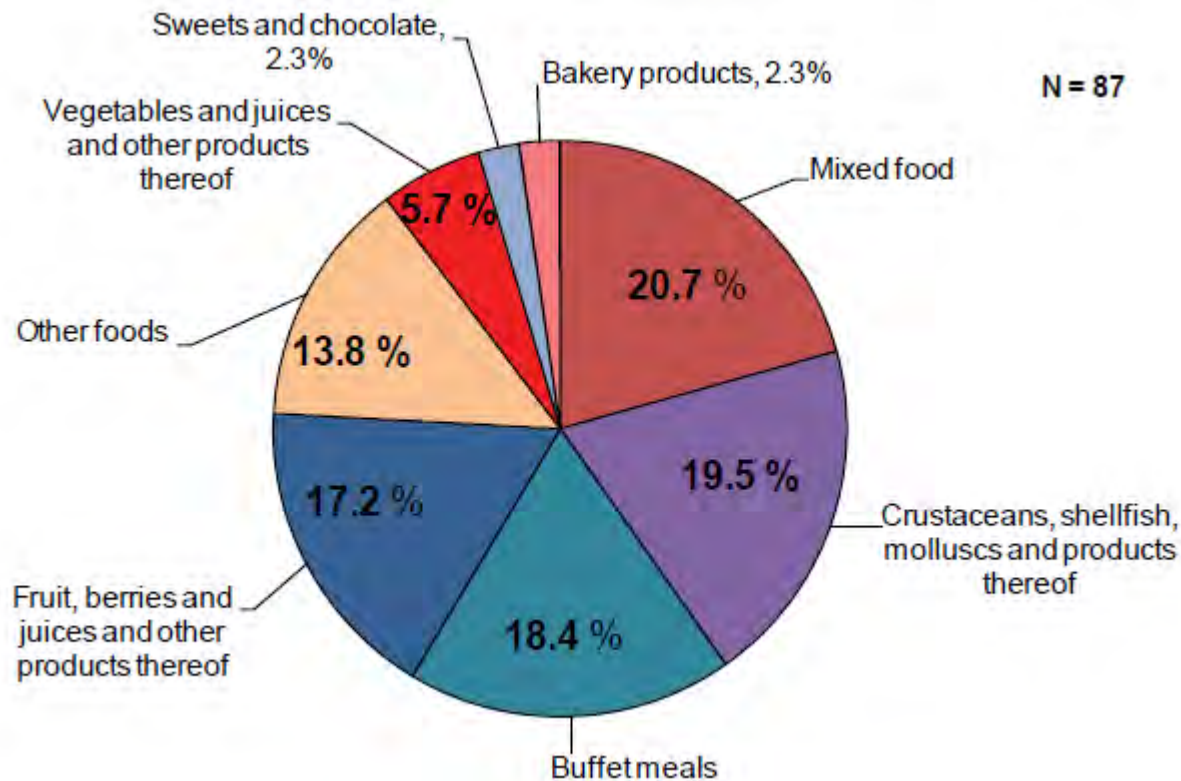
Foodborne viruses - norovirus

- transmission mainly from person to person
- contamination of foods by:
 - infected food handlers
 - contaminated environments, water (e.g. shellfish, vegetables)

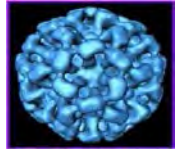


Foodborne viruses – EU 2011

Food vehicles related to calicivirus outbreaks



Foodborne viruses - norovirus



Norovirus outbreak in Germany, September/October 2012
>11.000 people ill, mainly school children

Suspect: Frozen strawberries imported from China used in
compote and soft curd cheese

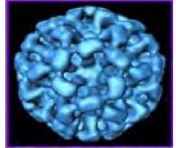




European
Commission

Foodborne viruses - norovirus

norovirus outbreaks on cruise ships 2012



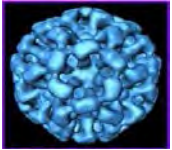
Cruise Line	Cruise Ship	Sailing Dates	Causative Agent
Cunard Line	<i>Queen Mary 2</i>	12/22 - 01/03	Norovirus
Princess Cruises	<i>Emerald Princess</i>	12/17 - 12/27	Norovirus
Prestige Cruise Holdings	<i>Oceania Riviera</i>	11/15 - 11/29	Norovirus
Holland America Line	<i>Amsterdam</i>	11/11-12/5	Norovirus
Princess Cruises	<i>Ruby Princess</i>	10/09-10/28	Norovirus and Enterotoxigenic <i>E. coli</i> (ETEC)
Princess Cruises	<i>Dawn Princess</i>	08/21-09/13	Norovirus
Royal Caribbean Cruise Line	<i>Rhapsody of the Seas</i>	08/24-08/31	Norovirus
Carnival Cruise Line	<i>Carnival Glory</i>	08/06-08/11	Norovirus
Princess Cruises	<i>Sun Princess</i>	07/08-07/21	Norovirus
Princess Cruises	<i>Ruby Princess</i>	02/26-03/04	Norovirus
Princess Cruises	<i>Crown Princess</i>	02/04-02/09	Norovirus
Celebrity Cruises	<i>Celebrity Silhouette</i>	01/29-02/10	Norovirus
Celebrity Cruises	<i>Celebrity Constellation</i>	01/28-02/11	Norovirus
Princess Cruises	<i>Crown Princess</i>	01/28-02/04	Norovirus
P & O Cruises	<i>Aurora</i>	01/04-01/26	Norovirus
Royal Caribbean Cruise Line	<i>Voyager of the Seas</i>	01/28-02/04	Norovirus



Source: CDC Vessel Sanitation Program

Foodborne viruses - norovirus

- Food handlers as a source of contamination -



Also in famous restaurants!

Copenhagen, DK

February 2013

67 people ill by norovirus

One ill food handler

Poor kitchen hygiene

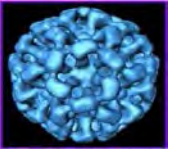
Bray, UK

February 2010

>500 people ill by norovirus

Staff members also ill

Oysters primary source?



Foodborne viruses - norovirus

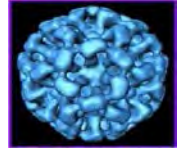
- Food handlers as a source of contamination -

Guidelines Codex Alimentarius

- If an outbreak has been traced back to an establishment, the necessary steps should be taken to find the source of contamination, to eliminate the virus, and to avoid future outbreaks
- Any food possibly contaminated by vomit particles or by aerosols containing vomit particles should be disposed of
- Any food handled by an ill person should be evaluated to determine the need to dispose of it

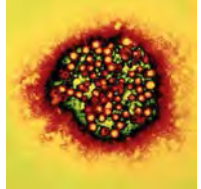
Foodborne viruses - norovirus

- Codex guidelines -

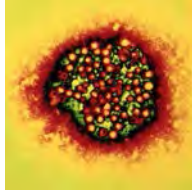


- Persons with symptoms of gastroenteritis should be excluded from handling food or from being present in food production or processing area
- Persons who have had gastroenteritis should only be allowed to return to work after a period without symptoms of diarrhoea and vomiting (e.g., period of 48 hours)
- Asymptomatic shedding of viruses may occur for 4-8 weeks and demands strict hygiene measures of the returned worker

Foodborne viruses - hepatitis A virus



- The disease, often asymptomatic or mild, particularly in children below five years, is a highly transmissible disease with an average incubation period of 28 to 30 days
- In adults, the onset of illness is usually abrupt with fever, malaise and abdominal discomfort. Jaundice is the predominant symptom. Symptoms may last between one and two weeks, up to months
- EFSA and ECDC reported 11 outbreaks between 2007 and 2011, with strong evidence of hepatitis A as the causative agent



Foodborne viruses – hepatitis A virus

Industrialised countries

- Good sanitary facilities
- Low prevalence of HAV
- Low immunity to HAV
- Impact infection:
 - illness (fatigue, liver infection)
 - 2% of infected adults have complications

Developing countries

- Poor sanitary facilities
- Moderate to high prevalence
- Immunity from childhood
- Impact infection: low

Food contamination via fecal-oral route

→ Fecal particles or vomits

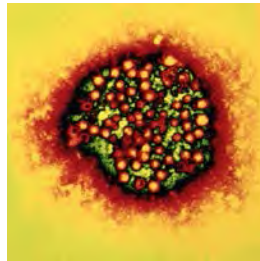
→ via contaminated hands, surfaces, or water

Foodborne viruses – hepatitis A virus

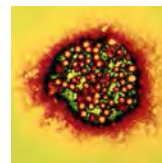
Semi-dried-tomatoes related to HAV patients

Australia, France and the Netherlands (13 patients), 2010

- Identical HAV strain identified in clusters of patients related to Mediterranean country
- Epidemiologic evidence from case-control studies for imported semi-dried-tomatoes as source



Foodborne viruses – hepatitis A virus

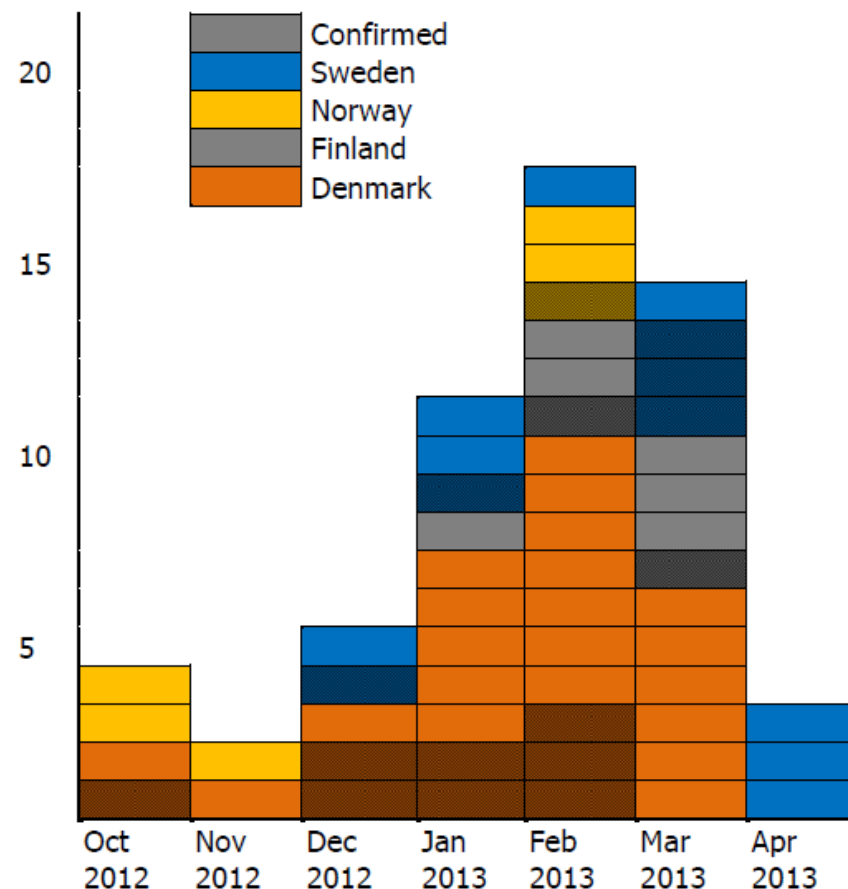


HAV outbreak Nordic countries

Oct. 2012 – April 2013

Suspect vehicle: frozen berries

71 cases in 4 countries

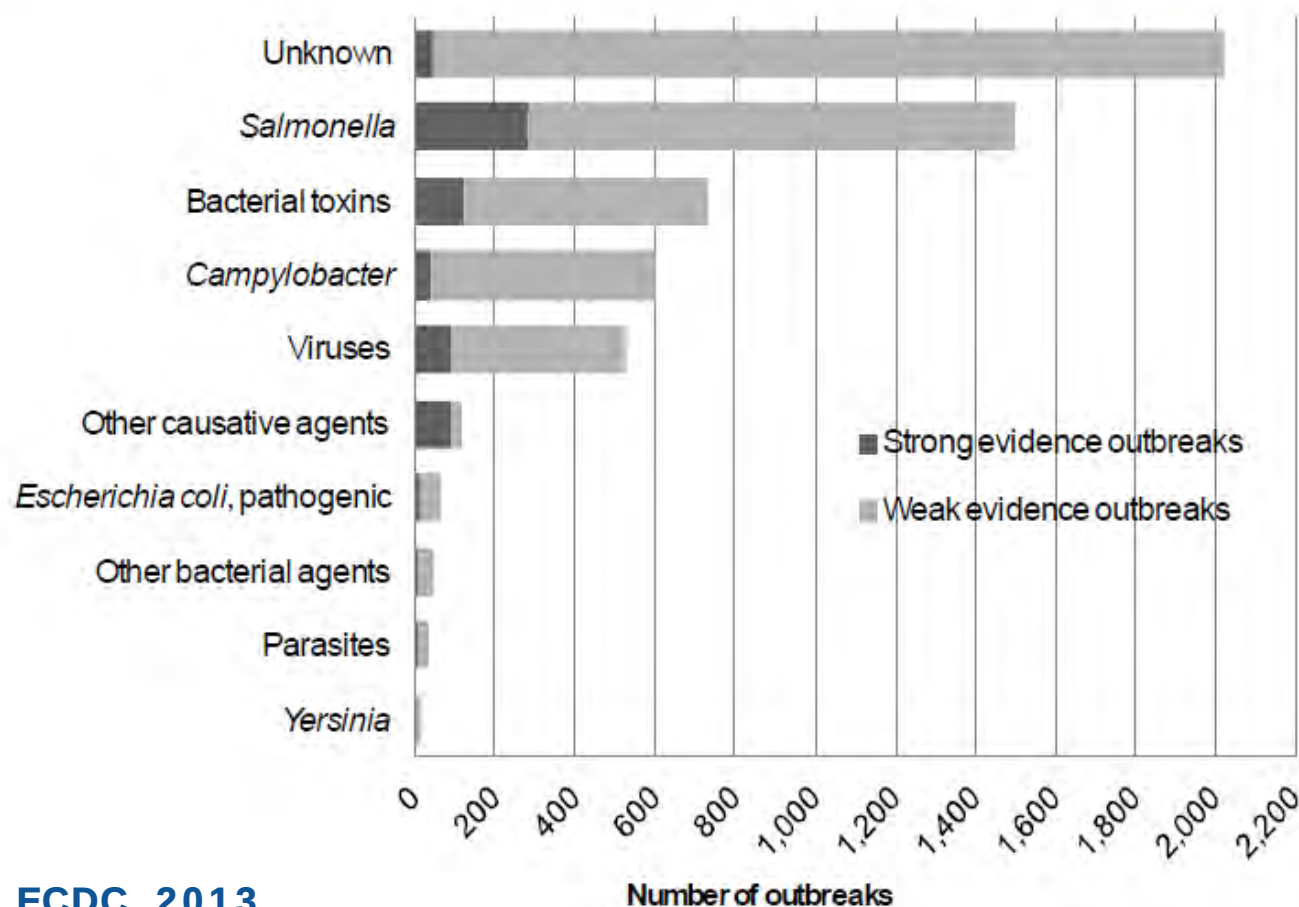


Euro Surveill. 2013;18(17):pii=20467

EFSA supporting publication 2013:EN-417

Toxin-producing and sporeforming bacteria

Figure SU2. Distribution of food-borne outbreaks per causative agent in the EU, 2011



Toxin-producing sporeforming bacteria

Bacillus cereus

characteristics

symptoms

infective dose

toxin produced

toxin

incubation period

duration of illness

diarrhoeal syndrome

abdominal pain,
diarrhoea

$10^5 - 10^7$

small intestine

heat-labile

8-16 h

24-36 h

emetic syndrome

nausea, vomiting
malaise

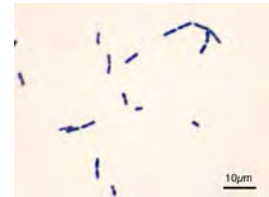
$10^5 - 10^7$

preformed in
food

heat-stable

1-5 h

24-36 h



Toxin-producing sporeforming bacteria

Bacillus cereus

Implicated foods

diarrhoeal syndrome

meat products
(fried/cooked)
soups, sauces
vegetables
puddings
milk (products)

emetic syndrome

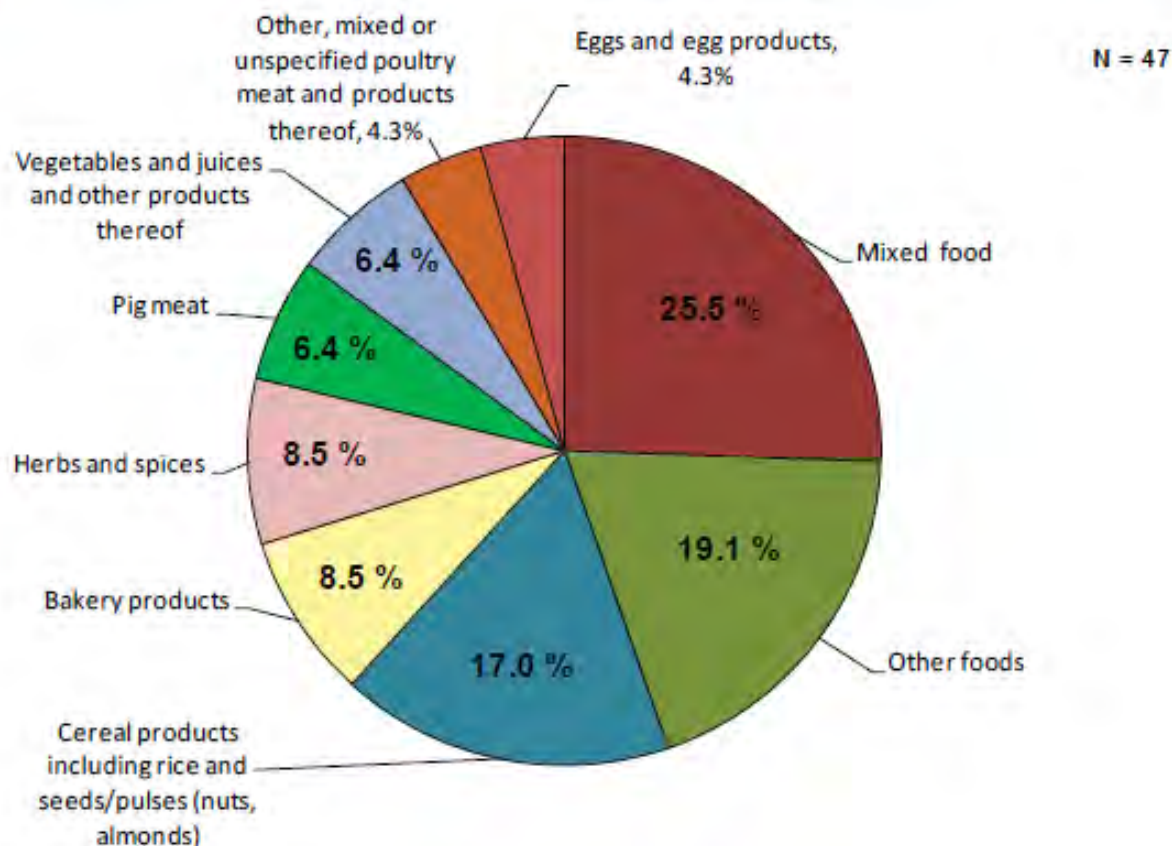
rice
pasta
noodles
pastry



Toxin-producing sporeforming bacteria

Bacillus cereus

Figure OUT18. Distribution of food vehicles in strong evidence outbreaks caused by Bacillus toxins in the EU, 2011

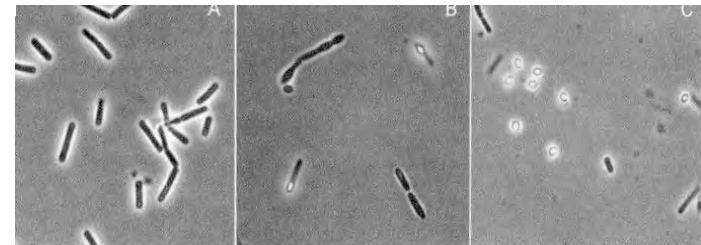


Toxin-producing sporeforming bacteria

- *Clostridium perfringens* –

Characteristics

- anaerobic sporeforming non-motile rods
- type A strains are widely spread in nature (soil, dust, water, intestinal flora of humans and animals)
- spores survive cooking



Toxin-producing sporeforming bacteria

- *Clostridium perfringens* –

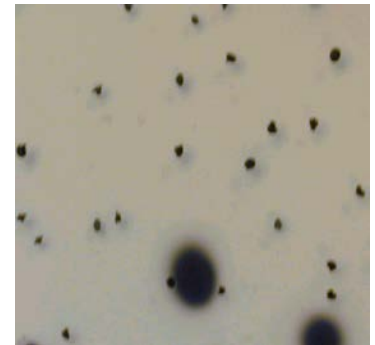
- *C. perfringens* cells survive stomach passage and sporulate in the intestinal lumen when large quantities of cells are ingested with food
- During lysis of cells to release the spore, the enterotoxin of *C. perfringens* (CPE) is set free (toxico-infection)
- Food poisoning symptoms are mild because *C. perfringens* cells and unbound CPE are flushed from the small intestine due to profuse diarrhoea.

Toxin-producing sporeforming bacteria

- *Clostridium perfringens* –

- Symptoms: acute diarrhoea, abdominal pain, nausea
- incubation time: 5-21 h
- period of illness: 1-2 days
- cause: ingestion of contaminated food;

food can become highly contaminated when insufficiently cooked and inadequately cooled and/or reheated before use



Toxin-producing sporeforming bacteria

- *Clostridium perfringens* –

A Clostridium perfringens outbreak traced to temperature-abused beef stew, Norway, 2012

Case definition: a swimming team member staying at the hotel from 20 to 22 January 2012, who fell ill with diarrhoea, abdominal pain or nausea

A total of 43 cases were identified

Median duration of symptoms of 35 hours

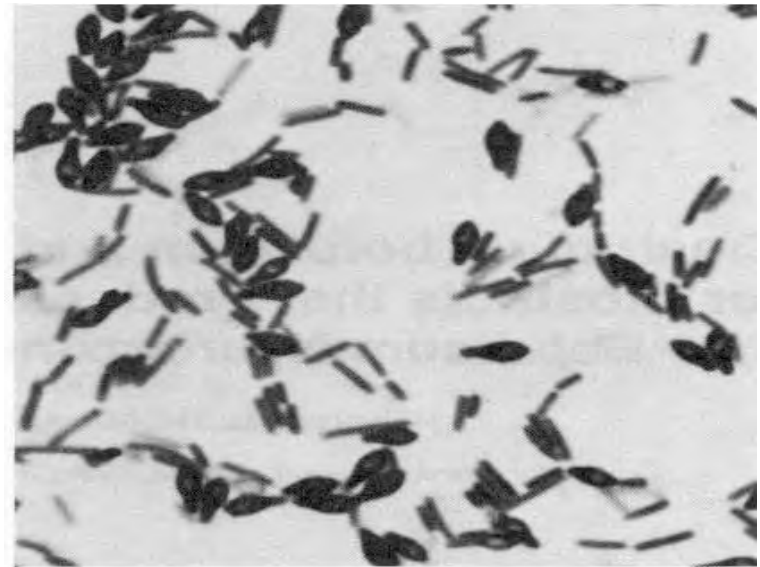
Clostridium perfringens (3.8×10^8 CFU) was isolated from beef stew eaten by cases.

Results of the investigation strongly indicated that cases were infected by *Clostridium perfringens* in beef stew that had inadequate temperature control during preparation.

Toxin-producing sporeforming bacteria

- *Clostridium botulinum* –

- *C. botulinum* type A,B,E,F produce heatlabile neurotoxins
- botuline is lethal (30-100 ng)
- incubation period: 12-36 h
- symptoms: disturbances of vision, dysphagia, weakness of the limbs and respiratory muscles, nausea, vomiting, approx. 10% of cases are fatal
- risk products: home-canned foods with low acid contents





Toxin-producing sporeforming bacteria

- *Clostridium botulinum* –

Foodborne botulism

- Incidence in EU (2006-2008): 477 confirmed cases (average 119/year)
- September to November 2011 three outbreaks
 - France – olive tapenades
 - Finland – almond-stuffed olives
 - Scotland – korma sauce

The products were marketed in glass jars with screw-top lids

Cowden J. 2011. Food-borne *Clostridium botulinum* intoxication from mass produced foodstuffs in Europe. *Eurosurveillance* 16 (49):20033

Toxin-producing sporeforming bacteria

- *Clostridium botulinum* –

Infant botulism

- Children less than 1 year have been affected
- disease characteristics: constipation, weakness, various neurological disorders
- hospitalization mostly required; fatal cases are rare
- cause: ingestion of clostridial spores and germination, multiplication and toxigenesis in the infant's intestines
- suspected food: honey
- exposure to spores from the environment

Toxin-producing sporeforming bacteria - *Clostridium botulinum* –

Infant botulism



**Pointers
For Parents**

**NO HONEY
DURING YOUR BABY'S
FIRST YEAR**

DO NOT add honey to your baby's food, water, or formula.
DO NOT dip your baby's pacifier in honey.
DO NOT give your baby honey as medicine.

Toxin-producing non-sporeforming bacteria

- *Staphylococcus aureus* -

Characteristics

- 50-70% of *S. aureus* strains are enterotoxigenic
- enterotoxins are heat-stable and are inactivated only by prolonged boiling
- source: humans (skin, nose, throat)
- intoxication by consumption of foods containing the enterotoxin



Toxin-producing non-sporeforming bacteria

- *Staphylococcus aureus* -

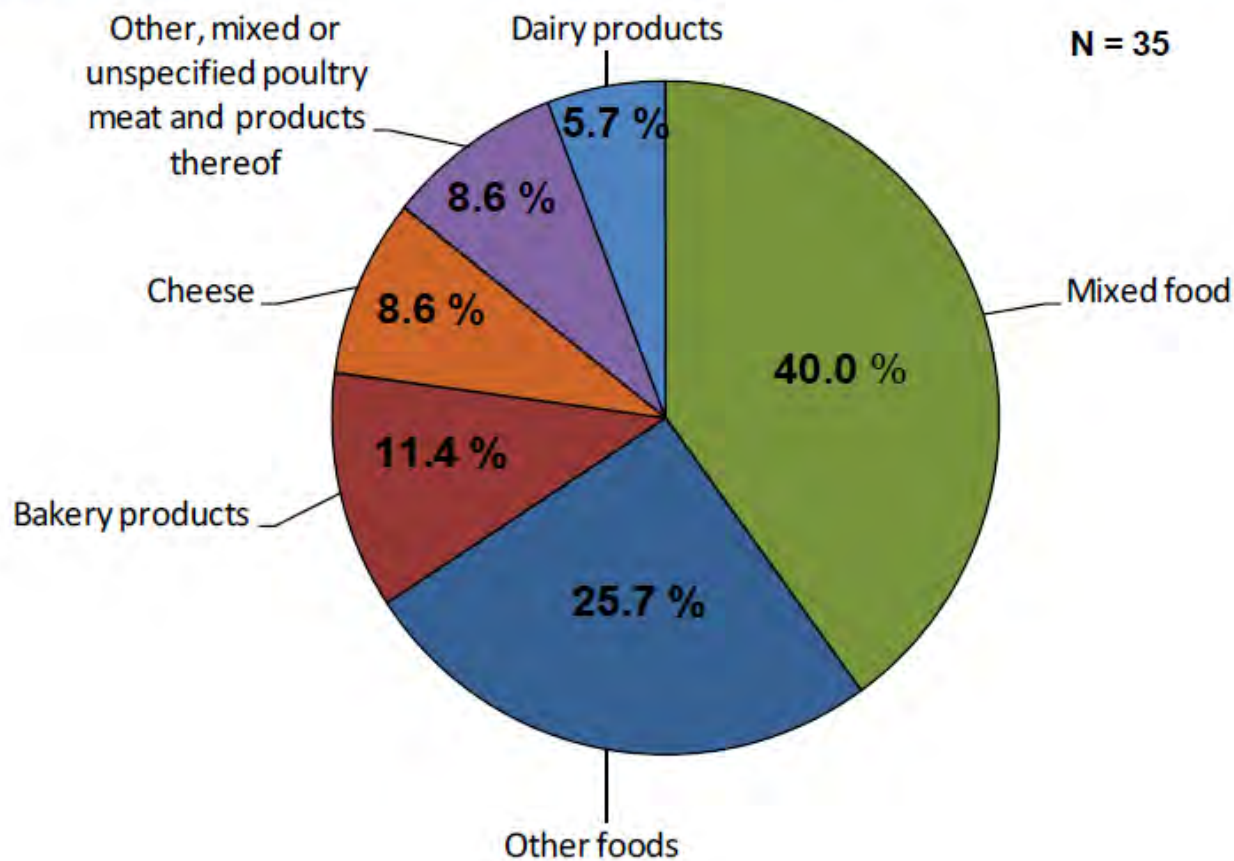
Staphylococcus aureus intoxications – characteristics

- symptoms: nausea, vomiting, abdominal pain, diarrhoea
- incubation time: 2 - 6 h
- period of illness: 1 - 3 days



Toxin-producing non-sporeforming bacteria - *Staphylococcus aureus* -

Figure OUT20. Distribution of food vehicles in strong evidence outbreaks caused by staphylococcal toxins in the EU, 2011



Toxin-producing non-sporeforming bacteria

- *Staphylococcus aureus* -

Food poisoning outbreak, Ardennes (Belgium)

- Warm summer day, Scouts' camp
- Lunch: milk, hamburgers, cheese, pasta (leftovers)
- 15 / 34 persons ill
- Patients hospitalised (1 overnight)
- Symptoms: nausea, vomiting, diarrhoea

I. Fitz-James, N. Botteldoorn, et al (2008) Food Micro 2008 Aberdeen

Toxin-producing non-sporeforming bacteria

- *Staphylococcus aureus* -

Food poisoning outbreak, Ardennes (Belgium)

Food control authority (BE)

- Sampling leftovers of suspected food (milk, hamburgers, cheese, pasta)
- Questionnaire: food consumption before onset symptoms, food preparation and –storage, purchase of foods and brands of food eaten
- Sampling hamburgers (same lot) at supermarket



Toxin-producing non-sporeforming bacteria

- *Staphylococcus aureus* -

Food poisoning outbreak, Ardennes (Belgium)

	HAMBURGERS (leftover scouts' camp)	HAMBURGERS (supermarket)
Total plate count	$3.6 \cdot 10^8$ cfu/g	$7.1 \cdot 10^4$ cfu/g
Coagulase pos. <i>S. aureus</i>	$8.1 \cdot 10^7$ cfu/g	$6.5 \cdot 10^4$ cfu/g
Staphylococcal enterotoxin (SET)	+ (SEA, SED)	- (<i>S. aureus</i> isolates: SEA)



Toxin-producing non-sporeforming bacteria

- *Staphylococcus aureus* -

Food poisoning outbreak, Ardennes (Belgium)

Hamburgers most likely source of the outbreak

Pointed to a particular processing plant in the Netherlands

Recall

Regulation (EC) No. 178/2002, art. 14

Food poisoning outbreak, Ardennes (Belgium)

Brussels, 13 August, 2007



FOOD

VERY URGENT - TRES URGENT

ALERT NOTIFICATION: 2007.0549

ORIGINAL NOTIFICATION

**SUBJECT: STAPHYLOCOCCAL ENTEROTOXIN AND
COAGULASE-POSITIVE STAPHYLOCOCCUS IN
FROZEN HAMBURGERS FROM THE NETHERLANDS**

Food poisoning outbreak, Ardennes (Belgium)

Food and Consumer Product Safety Authority (NL)

- Inspection at production plant of hamburgers
 - review production and handling procedures (HACCP)
 - sampling: hamburgers, similar snacks, semi-processed and end products, environmental samples
- Sampling hamburgers from processor in retail stores
- Microbiological analysis of samples: pathogens and their toxins

Food poisoning outbreak, Ardennes (Belgium)

Microbiological investigation

- Food samples production plant:
 - hamburgers (end products) positive for low numbers of *S. aureus*
 - varying levels of *S. aureus* per hamburger
 - no enterotoxins (SET) detected
- Food samples retail stores:
 - varying levels *S. aureus*
 - 6 / 40 (15%) samples positive for *S. aureus* ($> 10^5$ cfu/g); no enterotoxin (SET) detected
- Environmental samples:
 - *S. aureus* isolated from production lines (2/5), high levels *S. aureus*
 - isolates produced enterotoxin (SET)



Thank you for your attention!

