

**This information sheet looks specifically at the harvesting of live bivalve molluscs, routes of norovirus contamination and treatment options available to reduce contamination levels.**

## **What is norovirus?**

Noroviruses are a group of viruses that can be one of the most common causes of gastroenteritis or stomach bugs, and are often referred to as the 'winter vomiting virus'. It is estimated that norovirus affects up to three million people in the UK each year. Of these about 2.5% are related to the consumption of food.

Noroviruses are highly contagious – as few as 10 viral particles may be sufficient to infect an individual. When a person becomes infected with norovirus, the virus begins to multiply within the small intestine. After approximately 12 hours to 2 days, norovirus symptoms can appear. These include diarrhoea, nausea and vomiting. If dehydration is not treated, the very young and those people whose immunity to infection has been compromised are most affected.

Norovirus is easily transmitted from one person to another. The spread of norovirus is by:

- Person-to-person transmission
- Asymptomatic food handlers
- food borne transmission via salads, fruit and vegetables (raw, ready-to-eat food group)
- food borne transmission via 'ready to eat' bivalve shellfish (mainly contaminated raw oysters)

## **Norovirus and live bivalve molluscs**

Bivalve molluscs, which include oysters, mussels, clams, cockles and scallops, are filter feeders; they are susceptible to picking up and accumulating toxins or microbiological contaminants, including noroviruses, from their environment. Live bivalve molluscs have a unique ability to consolidate and retain substances from the water in which they grow.

For live bivalves the potential route of contamination is when human faeces containing norovirus from infected individuals enter the sea. Bivalves then filter the contaminated seawater and accumulate norovirus particles and retain them in their intestinal tract. When infected bivalves are consumed, without first being heat treated (cooked), consumers may become ill with norovirus.

## **Factors that affect levels of contaminants in mollusc flesh**

Seasonal conditions and the time of year affects the ability of the molluscs to filter seawater and retain virus particles. The distance from a point source of contamination and the quantity of faecal contamination discharged into a coastal area can be mitigated by dilution.

### Seasonal effects

Different species of bivalve mollusc have different rates of filtering and retention for a given water temperature. Generally the warmer the seawater the greater the amount of water filtered

by the animal and the higher the risk of potential contamination. However a higher water temperature increases a bivalves metabolism and can lead to rapid purging of the contaminant. Other environmental factors will influence the respiration rate or filtering activity of the mollusc, including salinity and dissolved oxygen. Even different individual shellfish of the same species in the same small area can behave differently and accumulate different concentrations of viruses. This makes it even more difficult to predict the effect of the seasons or weather conditions on the accumulation rate of viruses by molluscs.

However there is an increased incidence of norovirus detected in bivalves in the winter months. This could be due to a number of factors:

1. The amount of norovirus in the human population has been reported as greater in the winter months.
2. Generally there can be increased rainfall, which can overwhelm sewage handling systems and cause contaminated 'storm water overflows' during the winter. This coincides with the time of increased levels of gastroenteritis in the community.
3. In winter months bivalve molluscs may filter and retain virus particles at a slower rate than during the summer. It will take them a great deal longer in winter to clear their intestinal tract of a contaminated meal than in summer.
4. Sunlight inactivates viruses, so lower levels of sunlight in the winter may aid the survival of norovirus particles in the coastal zone.

### Sewage treatment

The quantity of faecal contamination discharged into a coastal area and whether it is treated or not may be important considerations in evaluating the potential risk to human health. There are generally three levels of sewage treatment:

- **Primary** – crude sewage passes into tanks where the majority of solids settle and the liquid moves on. At some stage solids may be removed for further treatment or disposal.
- **Secondary or biological treatment** – where settled sewage flows into an oxygen rich environment that allows beneficial microorganisms to remove and oxidize many pollutants.
- **Tertiary** – where specific pollutants are removed using methods such as filters, reed beds or U.V. lamps.

Higher levels of sewage treatment, prior to discharge to sea, result in improved water quality and lower risk of mollusc contamination. However, even with the best (tertiary) treatment plant available, the effluent can still be discharged in a raw or highly contaminated state when high rainfall occurs. It is not always possible to fund and build sufficient holding tanks for storm conditions. Therefore, adequate sewage treatment can only be expected to reduce the level of norovirus discharged to sea in reasonable weather conditions.

Although the quality of coastal water (and water classification) is outside the control of the bivalve shellfish gatherers or producers, they can help to control the risk of norovirus entering the food supply chain. This can be done by registering for pollution alerts if available and taking 'Active Management' measures such as cancelling or delaying harvest or moving to a different harvesting area.

### **Norovirus and *E. coli***

Because viruses are very difficult to count in seawater directly, an *E. coli* assessment is used to estimate the extent of faecal contamination in a shellfish harvesting area. However there is not a clear relationship between *E.coli* and norovirus. This means that the *E.coli* value may be low but the level of norovirus can be low or very high.

There are no current plans to use norovirus measurements (See *Measuring norovirus using DNA-based techniques*, below) to determine the classification of shellfish harvesting waters. An EU 'Baseline Survey' is shortly to be undertaken in some harvesting waters to establish the

level of norovirus present in oysters at that time. As the level of norovirus varies dependent on weather and hydrological factors as well as local community infection, it is not certain at the time of writing if this exercise will produce a sustainable risk tool.

Should a norovirus standard be introduced for classification of harvesting grounds it is unlikely that the E. coli test methodology will be discontinued.

### **Treatment options to reduce contamination levels**

Live or raw oysters that are not heat treated are a higher risk food product than any cooked mollusc dish. There are methods that can be used to mitigate for the presence of the virus.

#### Heat Treatment

EU legislation gives guidance on this by specifying that shellfish should be heated to an internal temperature of 90°C for 90 seconds or other approved method (EU Regulation 853/2004) to produce a safer seafood product. Note: freezing is unlikely to inactivate norovirus.

#### Purification Technology

Holding live bivalve molluscs in good quality water in controlled conditions (tanks) may help to reduce the total viral load, but there are no indications that the current minimum time of purification at 42 hours is sufficient to clear all viral contamination. Should there be any perceived increased risk of norovirus contamination, the duration of the purification period should be extended and the temperature of the seawater in the tanks elevated to as high as 18°C for oysters. Relaying oysters into good quality seawater prior to purification is also believed to have a beneficial effect, especially if the period of relaying is for long periods of time.

Using bacteriophage as an indicator of viral contamination suggests that holding the animals for 4 or 5 days at elevated temperatures may eliminate a viral threat to consumers from ready-to-eat oysters. Industry members are constantly seeking new processes and technologies that may be adapted to ensure safer seafood.

Some industry members are reported to have developed enhanced purification profiles which may include very long relaying and purification cycles, possibly including feeding the molluscs inactivated phytoplankton to aid purging of norovirus from the bivalves' intestinal tract.

Other developments have included the use of active bio-filters and the use of ozone to clean the water that the animals are held in.

### **Measuring norovirus using DNA-based techniques**

Viruses undergo genetic change by several mechanisms and there are many different 'types' or 'strains' of norovirus. The different 'strains' of norovirus are grouped as Genotype I and Genotype II. Whilst the Genotype I norovirus is thought to be as common as Genotype II, it is Genotype II which is thought to cause 90% of outbreaks.

Until very recently, it was not possible to quantify the actual number of viral particles in a sample of mollusc flesh. This has now changed and modern techniques, including those based on the polymerase chain reaction (PCR), can give precise numbers of viral particles in a sample. Unfortunately, science cannot tell us yet whether the virus particles detected are 'viable' and able to infect a human or not.

Complex equipment and skilled personnel are required to estimate the total number of virus particles in a sample. It can be expensive, at about £190 a sample. It is also difficult to quantify how representative the sample is – it could represent 25 oysters, 2,500 animals or 3 days harvesting.

## Active Management

'Active Management' is the flexible application of controls by the harvester in order to reduce risks to the consumer. This may involve cancelling or delaying harvesting as well as moving the harvesting operation to another location. Another way to view this is to take a positive perspective and only harvest when the contamination risk is low. This would need knowledge of tides, wind driven currents, discharges from 'Combined Sewer Overflows' (CSOs) and other measures determined by a flexible application of HACCP.

Seafish has worked with water companies and industry to pilot text alerts directly to harvesters when a 'start' and 'stop' criteria for a specific CSO has been issued. This initiative is now being managed by the Shellfish Association of Great Britain (SAGB).

## End Product Testing

Seafish has been advised that any laboratory used for enumeration of norovirus should follow the methodology outlined in the ISO 15216-1, the standard method for detection of norovirus in foods, ensuring appropriate quality control is in place. It is the responsibility of the business commissioning laboratory tests to ensure the method used by the laboratory is valid.

Further information may be found in the following document and others.

*International Standardisation of a Method for Detection of Human Pathogenic Viruses in Molluscan Shellfish. / Lees, David; Schultz, Anna Charlotte.  
In: Food and Environmental Virology, Vol. 2, No. 3, 2010, p. 146-155.*

## What is the risk of norovirus from eating live bivalve molluscs?

The number of people in the UK who contract norovirus from eating live bivalve molluscs is relatively very small. It is believed that if no one consumed oysters in the UK, the human population would still retain norovirus. The table below gives the best information Seafish can collate for England. We have been unable to gather similar data for the rest of the UK.

Year	All Foodborne Outbreaks	Foodborne Norovirus Outbreaks	Norovirus Outbreaks from Bivalves
2000	98	11	2
2001	91	9	1
2002	71	10	0
2003	71	5	1
2004	56	3	2
2005	81	10	2
2006	59	3	3
2007	42	3	2
2008	15	0	0
2009	95	14	12
2010	63	10	11
2011	84	8	1

2012	53	5	2
2013	82	14	4
2014	72	13	4
2015	47	3	1
<b>Total</b>	<b>1,080 (100%)</b>	<b>121 (11.2%)</b>	<b>48 (4.4%)</b>

Table data sourced from HPA and eFOSS

Foodborne transmission via bivalve shellfish (mainly contaminated raw oysters) is one (but the least likely) way of contracting norovirus. Although the risk may be considered to be low, bivalve molluscs should be commercially harvested only from approved production areas

## Summary

- You can get norovirus from eating contaminated food including shellfish.
- Bivalve molluscs filter norovirus from the water in which they grow. Due diligence is needed, especially for (live) ready-to-eat oysters.
- Bivalve molluscs should only be commercially harvested from approved production areas, which are monitored to ensure they meet strict toxin and microbiological criteria.
- Enhanced depuration has been claimed by industry members to reduce the total norovirus load, although the current minimum 42 hour purification time may not completely remove norovirus.
- It is now possible to quantify the amount of norovirus in mollusc flesh. The figure produced does not indicate the amount that can infect a consumer.
- The quality of coastal water is outside the control of the bivalve shellfish gatherers or producers. However participation in an 'Active Management' regime may reduce the risk to the consumer
- Heating molluscs to 90°C for 90 seconds or another processing profile may inactivate the virus.

**If you have any doubts do not harvest and seek advice.**

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