DEPURATION CONDITIONS FOR GREAT SCALLOPS (*Pecten maximus*)

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Introduction

Sewage-contaminated bivalve molluscan shellfish can present a significant health risk if consumed raw or lightly cooked (Cliver 1997, Rippey 1994). To minimise these health risks controls on harvesting of live bivalve shellfish are present (Lees 2000). European Directive 91/492 (Anon 1991) requires classification of shellfish areas depending on the degree of faecal pollution, as judged by *Escherichia coli* contamination. Moderately polluted shellfish can be treated by self-purification in tanks of clean seawater by a process termed depuration (Richards 1988). Shellfish treated in this way must comply with an end-product standard of <230 *E. coli* 100 g^{-1}.

Scallops, fished in offshore locations, are traditionally deemed to be microbiologically secure and so are exempt from classification requirements (Anon 1991). However, there is increasing interest in farming great scallops (*Pecten maximus*) inshore. Scallops are capable of accumulating sewage-derived micro-organism (Silk, 2000).

In order to ensure farmed scallops meet the end-product standard they require treatment. Depuration conditions have been carefully determined in the UK for a variety of bivalve species but have not been determined for scallops. This study investigated parameters affecting depuration. The aim was to produce sufficient information to allow depuration criteria for scallops to be determined.

Materials and Methods

Experimental animals and environmental contamination

Scallops obtained from a commercial cultivation site were distributed into lantern nets suspended from floating pontoons (Figure 1). Nets were left for two weeks to allow microbiological (*E. coli*) contamination. Scallops were subsequently collected and transported to the laboratory in 40 L bins covered with a dampened hessian sack in under three hours.

Figure 1: Recovering lantern nets of King scallops (Pecten maximus) for depuration trials.

Figure 2: A laboratory scale depuration system with a tray of scallops (Pecten maximus)

Depuration Tanks and Operation

Experiments were carried out in two types of depuration tanks. Laboratory scale systems described previously (Doré and Lees, 1995) had dimensions of 1050 mm (length) by 500 mm (width) by 450 mm (depth) with a working volume of 200 L (Figure 2). Standard design small-scale commercial systems described previously (SFIA 1996) had dimensions 1140 mm (length) x 950 mm (width) x 600 mm (depth) with a working volume of 550 L. Both systems were operated has described previously (Doré and Lees, 1995; Doré *et al.* 1998).

Contaminated scallops were washed and damaged shellfish discarded. Prior to depuration an initial sample of 20 scallops was removed and analysed as duplicate samples of ten animals. Scallops were loaded into mesh baskets with cupped shell down in a single layer. Following an initial trial using what was believed to be optimal conditions, trial parameters were changed to investigate the effect of artificial seawater, salinity levels, temperature, emersion time prior to depuration and loading arrangements. All depuration experiments were run for 42 - 48 h after which duplicate samples of 10 scallops for each treatment were removed for *E. coli* analysis. Levels of dissolved oxygen, temperature, ammonia and pH were recorded periodically throughout the depuration period.

E. coli analysis

Scallops were analysed for *E. coli* using a most-probable-number (MPN) method used for shellfish analysis (Donovan *et al.* 1998) (Figure 3).

Figure 3: The E. coli analysis is been carried out showing the most-probable-number (MPN) method

Results

Initial depuration experiment

An initial experiment using what was considered to be ideal conditions (salinity, 36 ‰; temperature, 15 ± 1°C; scallop to water ratio 1:50, Dissolved oxygen above 90% saturation) demonstrated reductions of *E. coli* levels from 805 MPN 100 g^{-1} to non-detectable levels.

Artificial seawater and the effect of salinity concentration

Initial salinity trials used artificial seawater made with standard salt mixes dissolved in potable water showed poor *E. coli* elimination and high mortalities regardless of salinity concentrations. A further trial compared diluted natural seawater with artificial seawater (salinity 30‰). Artificial seawater caused 100% mortalities compared with no mortalities with diluted natural seawater. *E. coli* levels in shellfish in the natural seawater tank were reduced from 265 MPN 100 g^{-1} to 20 MPN 100 g^{-1} indicating successful depuration. Further studies indicated that it was not possible to use artificial seawater to depurate scallops. Studies indicated that an unknown constituent in the untreated water salt solution caused the mortality, which could be removed by activated carbon filtration. Salinity trial results are shown in Table 1.

Table 1: E. coli levels in scallops before and after depuration under varying salinity ranges. All values are averages of duplicate samples. Artificial seawater was made using standard salt water mixes dissolved in water treated with an activated charcoal filter

Trial date	Salinity (‰)	*E. coli* MPN 100 g^{-1} Pre-depuration	*E. coli* MPN 100 g^{-1} Post depuration	Percent reduction
13/3/01	25	465	210	55.2
24/4/01	28	330	<20	>94
13/3/01	30	465	<20	>96
24/4/01	30	330	<20	>94
2/5/01	30	2,300	<20	>99

Temperature trials

Depuration experiments were carried out at 7, 10, 16 and 20°C. Depuration was incomplete at 7°C. Depuration at 10, 16, and 20°C was shown to be effective at reducing *E. coli* to end product levels even from levels consistent with a heavily polluted harvesting area.

Emersion time before depuration

Scallops were emersed at 15 ± 1°C for a total of 6, 10 and 22 h before being depurated at 14 ± 1°C for 42 h. *E. coli* levels of 1200 MPN 100 g^{-1} were reduced to 30, 30 and 145 MPN 100 g^{-1} for 6, 10 and 20 h emersion treatment respectively. *E coli* levels were successfully reduced to below the end product standard level, although it appears that 20 h emersion may have a detrimental effect on depuration efficiency.

Loading arrangements

An initial trial was conducted with 60 scallops loaded in two layers, cup side down, into one basket in a laboratory scale depuration tank under optimal conditions. During depuration scallops escaped from the baskets. Further trials placed mesh nets over the baskets so that the scallops could not escape but could filter feed (Figure 4). Following depuration, samples were taken randomly from the top and bottom layers of the basket. The efficiency of *E. coli* removal was similar. Three trials were conducted in commercial scale depuration system fully loaded with double layer of 50-60 scallops in each of 6 baskets. This gave a scallop to water ratio of 1:12. Trials were carried out at 15 ± 1°C and a salinity of 36 ‰. Control tanks containing only 20 scallops were used (scallop to water ratio in excess of 1:50). In all cases, *E. coli* levels were reduced to below 230 MPN 100 g^{-1}.

Figure 4: Increased scallop loading causes them to escape onto the base of the tank

Conclusions

Initial trials indicated that it was possible to successfully depurate moderately polluted scallops using standard UK depuration procedures. Subsequently this study concentrated on finding the minimum acceptable requirements for critical parameters when depurating scallops. The following recommendations are made;

- Artificial seawater should not be used to depurate scallops until further work is carried out.
- The minimum salinity concentration that should be used is 30 ‰.
- The minimum temperature that should be used is 10°C.
- Depuration should commence within 10 h of harvesting.
- Scallops should be contained in baskets at a maximum density of 250 scallops m^{-2} during depuration without constraining their ability to open.
- Scallop to water ratios should not fall below 1:12.

References

Anon 1991. Council directive of 15 July 1991 laying down the health conditions for the production and placing on the market of live bivalve molluscs (91/492/EEC). *Official Journal of the European Communities* 268, 1-14.

Cliver, D.O. 1997. Virus transmission via food. *Food Technol.* 51, 71-78.

Donovan, T.J., Gallacher, S., Andrews, N.J., Greenwood, M., Graham, J., Russel, J.E., Roberts, D. and Lee, R. 1998. Modification of the standard method used in the United Kingdom for counting *Escherichia coli* in live bivalve molluscs. *Com. Dis. and Public Health* 1, 188-196.

Doré, W.J. and Lees, D.N. 1995. Behaviour of Escherichia coli and male-specific bacteriophage in environmentally contaminated bivalve molluscs before and after depuration. *Appl. Environ. Microbiol.* 61, 2830-2834.

Doré, W.J., Henshilwood, K and Less, D.N. 1998. The development of management strategies for control of virological quality in oysters. *Water Science & Technology* 38, 29-35.

Lees, D.N. Viruses and bivalve shellfish. *International Journal of food Microbiology*. 59, 81-116. 2000.

Richards, G.P. 1988. Microbial purification of shellfish a review of depuration and relaying. *J. Food. Prot.* 51, 218-251.

Rippey, S.R. 1994. Infectious diseases associated with molluscan shellfish consumption. *Clin. Microbiol.* Rev. 7, 419.

SFIA 1996. Degritting of King Scallops. Seafish report No. SR468. Hull, UK: Seafish Industry Authority.

Silk R. 2000. Might scallops need depuration? *Shellfish News* 10, 7-8.

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