Monitoring and control of the potato brown rot bacterium in industrial potato washings

BPC TACKLING PESTS & DISEASES

Potato brown rot poses a serious threat to GB potato production and vigilance is required to prevent its introduction and spread. Several isolated cases have occurred linked to the presence of the causative bacterium (*Ralstonia solanacearum*) in certain watercourses. The handling of imported potatoes is one potential source of this contamination, so this leaflet reports research on the monitoring and control of the bacterium in industrial potato washings.

Summary

- This pathogen has quarantine status in Europe
- Washing and/or processing of potatoes from affected areas could contaminate GB watercourses
- A new automated molecular diagnostic test means the pathogen can now be reliably detected in industrial potato washings and sewage effluents
- As such, effluents from industrial potato washing can be monitored before release into the environment
- The test has also been used to validate a range of secondary waste treatments for control of the bacterium and resulting guidance is given in this leaflet.

Introduction

Potato brown rot is caused by a bacterium (*Ralstonia solanacearum*) and can seriously damage potato production. This pathogen has quarantine status in Europe to restrict its spread. Isolated outbreaks in ware potatoes have recently occurred for the first time in the UK - two in the Thames valley (in 1992 and 1995), two in Northamptonshire in 1999 and one in Kent in 2000. The same organism has also caused bacterial wilt disease in tomato in Bedfordshire (1997 and 1998).

Similar sporadic outbreaks have also been recorded in most other EC countries since 1989 and have resulted in official controls on infected crops and restriction on further planting in affected areas. The bacterium appears to have entered the EC in infected ware potatoes imported from third countries. It has entered certain watercourses, possibly in industrial or municipal effluents containing potato washings, and become established in the weed host, woody nightshade (*Solanum dulcamara*), which commonly inhabits river banks.

Transmission to potatoes and tomatoes has then resulted from irrigation with contaminated river water. Irrigation and spraying with water from watercourses designated as contaminated has therefore been prohibited.

This three-year Sustainable Arable LINK project aimed to provide the potato and water industries with practical tools for effective monitoring and control of the brown rot bacterium to prevent its further establishment in UK river systems, while protecting the reputation and sustainability of the UK potato industry.

Primary treatment - aerated settlement lagoon.

The research involved collaboration between the Central Science Laboratory, ADAS Consulting Ltd, DEFRA (Department for Environment, Food and Rural Affairs) Plant Health and Seeds Inspectorate, the Potato Processors' Association, UK Water Industry Research Ltd, the British Potato Council, Greenvale AP plc, Wm. Morrison Supermarkets plc, McCain Foods (GB) Ltd. and waste treatment specialists from Haith Industrial Ltd, Degussa Ltd, and AECS Ltd. Industry support was matched by DEFRA and Scottish Executive Environment and Rural Affairs Department under the Sustainable Arable LINK programme.

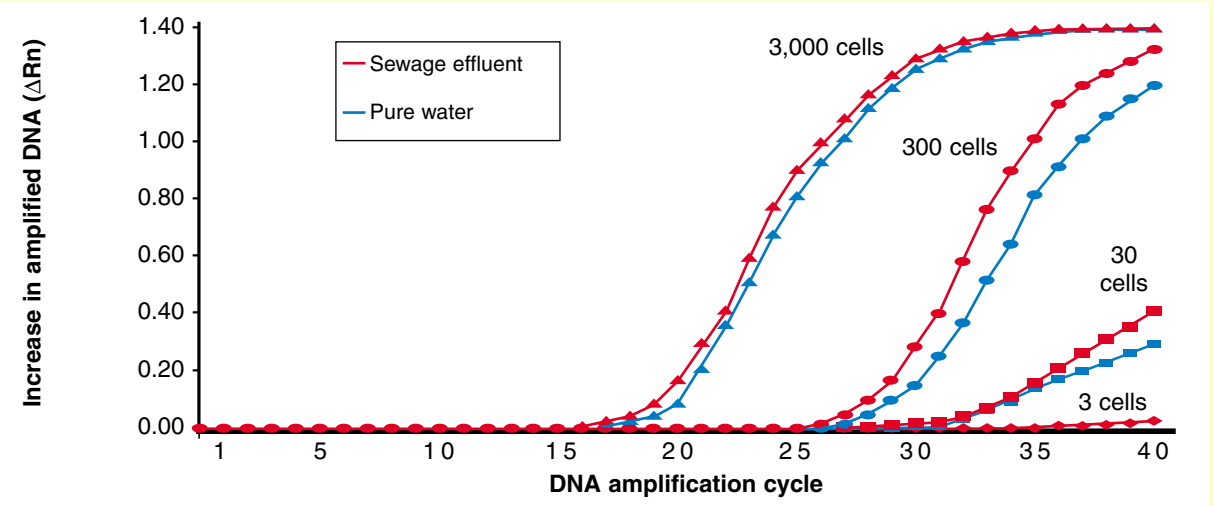
Woody nightshade - key features to assist identification.

Primary treatment - sedimentation of solids.

Pathogen detection

Previous methods used to detect the brown rot bacterium in plant material and river water are not suitable for monitoring its presence or viability in industrial potato washings or municipal sewage.

A new test uses a combination of traditional laboratory methods and quantitative DNA amplification technology to simultaneously enrich, detect, identify and determine the viability of the pathogen in a sample.



Pathogen detection and quantification by TaqMan assay in sewage effluent and pure water.

This test has been shown to reliably detect low pathogen populations in potato washings and sewage effluents, even in the presence of millions of other non-pathogenic bacteria. Sensitivity of detection was found to be near or equal to that obtained for similar pathogen populations suspended in pure water. Testing of potato washings and effluents involves regular sampling of 500ml quantities, which should be tested within 24 hours.

In summary:

- The new automated molecular diagnostic test for the brown rot bacterium is rapid, sensitive and specific
- It detects, quantifies, identifies and determines the viability of the pathogen in the sample
- The pathogen can now be reliably detected in industrial potato washings and sewage effluents
- The test can monitor effluents from industrial potato washing for freedom from the bacterium before release into the environment.

Probability of infection

Strengthening of official controls and testing programmes in recent years has significantly reduced the risk of finding the potato brown rot bacterium in imported and EU-produced potatoes intended for packing or processing. Legislation (Council Directive 98/57/EC on the control of *Ralstonia solanacearum*. Commission Decision 96/301/EC and amendments. Potatoes originating in Egypt Regulations 1998 and amendments) has ensured that potatoes imported from certain third countries are grown only in areas recognised as free from the pathogen, that produce is appropriately inspected and tested, that traders are registered and that packing houses approved to handle certain imported produce.

Official measures also ensure that regular surveys identify the limits of pathogen distribution within the EU and that potato crops are not irrigated with infested surface water. In the UK, additional measures have been taken to remove infected *Solanum dulcamara* from some contaminated waterways with a view to eradicating the pathogen altogether. Nevertheless, the organism has occasionally been detected in industrial potato washings.

Large numbers of bacteria can spread from single infected tubers and the bacteria can survive in potato washings for several days or even weeks. Risk assessments should therefore assume a low risk that the organism could be present in ware potatoes from any source intended for packing or processing.

Validated waste treatment methods

Industrial potato washings usually undergo primary settlement treatments to separate solid and liquid waste. Where a risk of contamination with the brown rot bacterium or other quarantine pathogen is perceived, solid waste is usually transported to licensed landfill sites for deep burial at high cost. Disposal of liquid effluents via municipal sewage treatment has been shown to present a low risk of pathogen dissemination, provided all material is guaranteed to undergo the treatment.

Assessing risks

To assess the risks of spreading potato brown rot during potato processing and packing:

- Follow the general advice given in the *Code of practice for the management of agricultural and horticultural waste* (available from DEFRA Publications, Admail 6000, London, SW1A 2XX)
- Contact your local office of the PHSI or SEERAD, or check the DEFRA website (***www.defra.gov.uk/planth/ph.htm***), for advice on areas and countries where the organism has been recently found or from which infected imports have been intercepted
- Be especially vigilant during quality inspections for symptoms of potato brown rot and report suspect findings immediately to your local PHSI or SEERAD office. Test kits are available which can be used for rapid on-site preliminary diagnosis of suspected cases
- Ask your local PHSI or SEERAD office to assess the reliability of existing waste disposal measures by considering the potential for dispersal of the pathogen into the environment in waste solids and effluents
- Consider having tests performed on washings and waste effluent to assess the reliability of currently used waste treatment measures
- If risks of spreading the brown rot bacterium during potato waste disposal are perceived, consider additional secondary waste treatment measures (see later). Seek further advice from your local Environment Agency or Scottish Environment Protection Agency (SEPA) office on choice of suitable secondary treatments.

Discharge of liquid effluents directly to watercourses represents the highest risk of spreading potato brown rot through infection of *S. dulcamara* growing in the watercourses. A number of alternative secondary treatments have therefore been evaluated for reliable control of the brown rot bacterium in industrial potato washings.

It is important to note that the reliability of these secondary treatments will vary from site to site depending on effluent quality and degree of primary treatment. Choice of treatment and specifications for their use will require careful consideration to ensure effective control of potential pathogen populations whilst maintaining effluent quality within environmental consents. This will require regular testing of effluents during installation of new treatment processes to maximise safety, reliability and cost effectiveness. It is therefore essential to contact the local plant health office and the Environment Agency or SEPA for further advice prior to opting for any of these secondary treatments.

1. Heat

The brown rot bacterium is killed when a temperature of 55°C is maintained for 10 minutes. For practical purposes, it is recommended that potato washings are exposed to temperatures of 75°C for at least 30 minutes. It is critical to ensure that this temperature is reached throughout the material so that the treatment is also valid for control of more temperature tolerant pathogens (avoiding the need for deep burial of soil residues). This temperature was shown to be achieved reliably under commercial conditions when excess steam (from peeling operations) was piped through slurry from coagulated and flocculated potato washings.

2. Anaerobic digestion

Some potato processors have dedicated anaerobic digestion treatment plants and can thus ensure that all waste is adequately treated. A retention time of at least 48 hours at either 35 or 38°C (well within the usual two week period) was shown to be required for complete control of the brown rot bacterium during anaerobic digestion. Since other pathogens may survive digestion, care may be required in disposing of the digested product.

3. Filtration

Removal of the brown rot bacterium from industrial potato washings by filtration is suitable only after primary sedimentation since all particles larger than 0.45μm must be removed. The solid waste component will therefore still require further treatment or safe disposal. Reed bed filtration systems have been shown to be reliably efficient in removing bacteria under commercial conditions. Filtration can also increase the efficiency of some other secondary treatments, e.g. by increasing transmission of UV or lowering the required dose of oxidising agents.

4. Oxidation

A number of chemical treatments have been shown to reliably kill the brown rot bacterium during oxidation of organic material in industrial potato washings. Treatment of slurries containing both solid and liquid fractions may be possible but lower doses are required to treat effluents after primary sedimentation. Thorough mixing of oxidising agent and effluent is essential and a critical residual level should be measurable for a minimum reaction time after mixing to ensure reliable pathogen control. Effective doses should be carefully calculated so that residual product is exhausted prior to discharge and that effluent quality (including suspended solids, BOD and COD) is not adversely affected by the treatment.

a) Peroxygen products - Oxidation occurs through the rapid activity of hydrogen peroxide and peracetic acid, which are then rapidly exhausted, leaving no undesirable residues. Complete control of the potato brown rot bacterium requires a residual level of at least 4mg/litre of peracetic acid, measurable for a minimum of two minutes. In one commercial-scale trial, this was achieved for all potato lots tested by dosing and thorough mixing of wash water with a commercial formulation (Clarmarin 150 from Degussa Ltd.) prior to emptying the washers, without affecting final effluent quality after sedimentation in large settlement lagoons.

b) Chlorine dioxide - Rapid oxidation of the brown rot bacterium in potato washings was shown to require at least 0.1mg/litre of residual chlorine dioxide, measurable over a two minute minimum reaction time. Use of chlorine dioxide at this rate is within the limits currently permitted for use in vegetable washing water. For example, this was achieved in one pilot trial under commercial conditions by injecting washing water (after chemical coagulation and flocculation of solids) with 8mg/litre using a chlorine dioxide generator from Prominent Fluid Controls (UK) Ltd.

c) Ozonation - Reliable control of the brown rot bacterium in potato washings requires a residual ozone concentration of at least 0.4mg/litre, measurable over a minimum reaction time of four minutes. In pilot trials under commercial conditions, this was achieved during treatment of clarified potato washings by dosing with at least 10mg/litre of ozone with a reaction time of at least four minutes using either an ozone generator from Prominent Fluid Controls (UK) Ltd or an ozone/active oxygen generator from AECS Ltd.

5. UV irradiation

Control of the brown rot bacterium in potato washings by irradiation at 300J/m^2 of UV light at a wavelength of 254nm was shown to be reliable provided that a transmission of at least 50% of the UV was recorded at all times through the effluent (to a depth of 1cm) within the reaction chamber. UV transmission is affected both by turbidity of the water and by the content of any dissolved solute which absorbs UV light. In trials under commercial conditions using a Dulcodes low pressure UV treatment system from Prominent Fluid Controls (UK) Ltd, reliable transmission levels were not always achieved in industrial potato washings, even following coagulation and flocculation of solids. In contrast, reliable transmission was achieved over time in a second trial in which effluent was treated following sedimentation and reed bed filtration.

Contacts

Dr John Elphinstone (Project Scientific Co-ordinator), Central Science Laboratory, Sand Hutton, York, YO41 1LZ
☎ 01904 462000 FAX 01904 462111
j.elphinstone@csl.gov.uk

Mr Richard Harris (Chairperson Project Consortium), Potato Processors' Association, 49 Stockerston Crescent, Uppingham, Rutland, LE15 9UA
☎ 01572 822428 FAX 01572 820015
potatoes.unlimited@virgin.net

For further information and general advice please contact your local offices of **PHSI** (in England), **DARDNI** (in Northern Ireland), **SEERAD** (in Scotland) or the **Welsh Assembly** (in Wales).

For further information on water discharge consents and regulations regarding waste treatment and disposal, please contact your local **Environment Agency** or **SEPA office**
www.environment-agency.gov.uk
www.sepa.org.uk

General guidance on safe disposal of agricultural waste is contained in *Code of practice for the management of agricultural and horticultural waste* (available from **DEFRA Publications**, Admail 6000, London, SW1A 2XX).

Given the devastating effects of brown rot, keeping it out of GB crops is clearly a major priority.

Project participants

The Potato Processors' Association

Mr Richard Harris (Chairperson Project Consortium), Potato Processors' Association, 49 Stockerston Crescent, Uppingham, Rutland, LE15 9UA
E-mail: *potatoes.unlimited@virgin.net*

Dr Chris Rowlands, UK Water Industry Research Ltd, 1 Queen Annes Gate, London, SW1H 9BT
E-mail: *Chris.Rowlands@severntrent.co.uk*

Dr Tim O'Neill, ADAS Consulting Ltd, ADAS Arthur Rickwood, Mepal, Ely, Cambridgeshire, CB6 2BA
E-mail: *Tim.O'Neill@adas.co.uk*

Dr Ewen Brierley, British Potato Council, 4300 Nash Court, John Smith Drive, Oxford Business Park South, Oxford, OX4 2RT
E-mail: *ebrierley@potato.org.uk*

Mr Ivor Schofield, Haith Industrial Ltd, Lawn Rd, Carlton in Lindrick, Worksop, S81 9LB
E-mail: *haith.industrial@virgin.net*

Mr Tony Smith, Degussa Ltd, Winterton House, Winterton Way, Macclesfield, Cheshire, SK11 0LP
E-mail: *Tony.Smith@Degussa.com*

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Dr John Elphinstone, Central Science Laboratory, Sand Hutton, York, YO41 1LZ
E-mail: *j.elphinstone@csl.gov.uk*

Ms Jane Cooper, Prominent Fluid Controls (UK) Ltd, Resolution Rd, Ashby de la Zouch, Leics, LE65 1DW
E-mail: *janecooper@prominent.co.uk*

Mr J David Willis, AECS Ltd, Unit A1, Sandy Business Park, Gosforth Close, Sandy, Beds, SG19 1RB
E-mail: *jameswillis@ntlworld.com*

Mr Paul Coleman, Greenvale AP plc, Floods Ferry Road, Doddington, March, Cambs, PE15 OUW
E-mail: *paul.coleman@greenvale.co.uk*

Mr Craig Lavender, William Morrison Produce Ltd, Cutler Heights Lane, Bradford, BD4 9LR
E-mail: *qc.cutler@morrisons.plc.uk*

Mr Andrew Sarney, McCain Foods (UK) Ltd, Havers Hill, Eastfield, Scarborough, YO11 3BS
E-mail: *asarney@mccain.co.uk*

British Potato Council, 4300 Nash Court, John Smith Drive, Oxford Business Park South, Oxford OX4 2RT
Tel: 01865 714455 Fax: 01865 782200
E-mail: research@potato.org.uk
Website: www.potato.org.uk