Microbials 'Keep it Clean' Conference

Tuesday 18 & Wednesday 19 February 2020

Warwick Crop Centre, The University of Warwick, Wellesbourne
CV35 9EF, UK

COST
EUROPEAN COOPERATION
IN SCIENCE & TECHNOLOGY

HUPLANT CONTROL
COST Action 16110

IWS
INTERNATIONAL WATER SOLUTIONS

AHDB

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AHDB Horticulture is inviting growers of edible horticultural crops to a 2-day Microbials 'Keep it Clean' event which has been organised in collaboration with the European Union COST 'HUPLANTcontrol' project team. The event brings together scientists working on fresh produce safety across the EU to the UK, to disseminate current knowledge and best practice to help growers to keep fresh produce safe to eat.

Day 1 Programme, 18 February 2020

Time	Title	Brief & Format	Speaker
10:00 – 10:30	**Registration**		
10:30 – 10:45	Welcome	Welcome delegates; event aims; programme order; demonstration arrangements, Health & Safety and other considerations	Grace Choto & Theresa Summers (AHDB)
Irrigation water disinfection presentation and demonstrations			
10:45 – 11:30	Irrigation water disinfection - practical considerations	*Presentation* Filtration before disinfection; flushing biofilm in pipework; ensuring for minimal disinfectant dosage to limit disinfection by-products in fresh produce; Disinfection verification procedures; Using Palin and other water tests.	Al Sayed, International Water Solutions
11:30 – 12:15	'Clean' Borehole water disinfection demonstration	Best practice chlorine-dioxide disinfection demonstrations. Delegates will be divided into two groups and will swop after 40minutes. Delegates must wear suitable clothing for outdoors and shoes with treads / wellies.	International Water Solutions Systems specialists
12:15 – 13:00	'Dirty' River water disinfection demonstration		
13:00 – 14:00 Lunch			
'Growing risks and mitigation'			
14:00 – 14:30	Practical risk-assessment and risk - management	*Discussion* led by Jim Monaghan What is risk assessment? How to do a risk assessment? Probability / Impact matrices and qualitative and quantitative considerations eg final irrigation date and weather before harvest implications. Risk management.	Jim Monaghan, Harper Adams University
14:30 – 15:00	Irrigation water sources, quality and application methods – risks & mitigation	*Presentation* Irrigation water matrix, Risks posed by different quality waters and different irrigation systems on different categories of crops. Define 'clean' water. Can dirty water sources be used for eg root crops that will be washed and brushed in clean water after harvest; Mitigation options.	Jim Monaghan
15:00 – 15:15	Where are we on chlorate and perchlorate?	*Presentation* To-date chlorate and perchlorate MRL proposals for fruit and vegetables; When will these be made legal? Will there be a grace period for growers post-MRL legalisation?	Ana Allende, CEBAS-CSIC, Murcia, Spain
15:15 – 15:45	Chlorate & perchlorate risks and mitigation	*Presentation* How to mitigate against chlorate and perchlorate exceedances in fruit and vegetables when using chlorine compounds for disinfecting water, equipment and surfaces	Mabel Gil, CEBAS-CSIC.
15:45 – 16:00	**Summary and End**		

Dinner is being arranged for those who have indicated a wish to dine with others. This will be at the Charlecote Pheasant Hotel, Stratford-upon-Avon, Warwick, CV35 9EW

Day 2 Programme, 19 February 2020

Time	Title	Brief & Format	Speaker
9:30 – 10:00	**Registration**		
10:00 – 10:10	Welcome	Welcome delegates; event aims; programme order; other considerations	Grace Choto, AHDB
10:10 – 10:30	'HUPLANTcontrol' – is there anything in it for growers?	*Presentation* Introducing the EU project. EU collaboration in science could improve the understanding of plant and soil microbiomes on the ecological behaviour of food safety pathogens. Should growers be driven to sanitise crop growing environments? Can an abundant and diverse microflora help prevent the growth and proliferation of food safety pathogens on crops? Will the proper identification of eg Bacillus species stop hoax food safety scares that impact on growers eg Bacillus species identification issues - uses in crop protection, probiotics and implicated in food poisoning.	Leo van Overbeek, Wageningen University, The Netherlands
Good Agricultural Practice and Good Hygiene Practice			
10:30 – 11:00	Microbiological organisms of most concern	*Presentation* Main microbes of concern in fruit and vegetables production; Factors affecting pathogen survival on crops and produce post inoculation along the fresh produce production chain – what is known from research work?	Mike Hutchison, Hutchison Scientific
11:00 – 11:30	Practices to help keep fresh produce safe to eat	*Presentation* EU Guidance on good agricultural & hygiene practices to reduce microbiological contamination risks in fresh fruit and vegetables production.	Ana Allende, CEBAS-CSIC, Spain
11:30 – 12:00	Risk-based microbiological sampling plans in fresh fruit and vegetables production	*Presentation* Guidance – How to take samples (i) in a growing crop and (ii) of produce in store for microbiological contamination testing.	Mieke Uyttendaele, University of Gent, Belgium
12:20 – 12:30	'*Listeria monocytogenes* and fresh produce'	*Presentation* Reducing Listeria contamination on produce	Mike Hutchison
12:30 – 13:30 Lunch			
Interactive training sessions - two groups rotating after 40 mins			
13:30 – 14:10	Assessing irrigation water for contamination risks	How and when to take water samples? Frequency of sampling? What to ask for in a water test? What are indicator species? Interpreting lab results. When to take corrective action?	Jim Monaghan
14:10 – 14:50	Trending microorganisms	What is trending? Why is it important? Should all growers trend? Frequency of trending? How to interpret trending patterns? When to take corrective action? Briefly - The Fresh Produce online risk-assessment tool.	Mike Hutchison
14:50 - 15:00	Evaluation forms – delegates will be asked to evaluate this 2 day event to help us to improve on the of planning future events		
15:00 – 15:15	**Summary and End**		

Speaker biographies

Al Sayed – International Water Solutions Ltd

One of the Founders and crucial to the development of XZIOX.

With over 20 years in the water disinfection market, Al has extensive experience in International markets. He has also developed many of the UK sectors that IWS are supplying to. His experience and knowledge have led to success in R&D and field trials.

Terri-Ann Boyle – International Water Solutions Ltd

Terri-Ann has been crucial in the development of building partnerships within the UK and abroad.

She has represented IWS in many forums throughout the globe. Her expertise in the agricultural sector has given IWS a huge advantage and we are now arguably one of the top solution providers to the water issue for agricultural development, Terri-Ann has also taken the lead in advances for approvals for IWS products around the globe.

Jim Monaghan Harper Adams University

Reader – Fresh Produce and Horticulture

Director – Fresh Produce Research Centre

Harper Adams University

Newport, Shropshire, TF10 8NB

Tel +44 (0)1952 815425

jmmonaghan@harper-adams.ac.uk

www.harper-adams.ac.uk

Jim Monaghan has worked in crop science for 25 years. Following a Biology degree at UCNW Bangor, Jim researched aspects of crop production at Harper Adams University College and John Innes Centre (PhD), Newcastle University, HRI-Efford and HRI-Wellesbourne. Jim then had a look at the real world for three years at Marks and Spencer as Salads Technologist, where he had responsibility for food safety, pesticide residue minimisation, and compliance with codes of practice for all salad products and salad ingredients in minimally processed foods, before heading back to Harper Adams to develop teaching and research in the area of fresh produce production in 2005.

Jim leads the Fresh Produce Research Centre at HAU which is focussed on fresh produce production, particularly leafy vegetables and covers three areas: 1) identifying genetic traits that may lead to more sustainable crop production; 2) agronomic manipulation of post-harvest quality and nutritional content in crops; and 3) developing and implementing food safety systems in fresh produce. Jim previously chaired the Technical Advisory Committee for Red Tractor Produce from 2010-17 and is a member of the BBRO Technical Committee.

Speaker biographies Cont'd….

Ana Allende, CEBAS-CSIC, Murcia, Spain

Senior Researcher – Safety of Fresh Produce

CEBAS-CSIC

Food Science and Technology Department

Campus de Espinardo, 25

30100 - Spain

Tel +34 968396200 Ext. 6377

aallende@cebas.csic.es

Dr. Ana Allende from CEBAS-CSIC (Spanish National Research Council) in Spain is a Senior Researcher with focus on quality and safety of fresh produce. She obtained her Degree at the Faculty of Veterinary Science at the University of León (Spain) and her PhD in Food Science and Technology at the University of Cartagena, (Spain). she holds several positions in (inter)-national institutions including vice-chair of the BIOHAZ panel at the European Food Safety Authority (EFSA), vice-director of the CEBAS-CSIC, Member of the Joint FAO/WHO Expert Meetings on Microbiological Risk Assessment (JEMRA) Roster of Experts, and member of the COST ACTION HuPlant. She has published more than 130 research articles in peer-reviewed international journals focused on the safety of fresh produce with more than 5000 cites. Her current H index is 40. She has built up more than twenty years of scientific research but also management experience by executing, initiating and guiding research projects in the area of microbial safety of fresh produce. Promotor of 7 PhD students (past and present).

Maria Isabel Gil

Mª Isabel Gil has a Pharmacy degree and a PhD in Biology. She is a senior researcher at the Spanish Research Council (CSIC) in the Food Science & Technology Department at CEBAS-CSIC institute in Murcia, Spain.

Her current research activities are related to the Quality and Safety of Fresh-cut Vegetables from preharvest to advanced postharvest aspects. She coordinates an expert group involved in fundamental and applied postharvest issues related to physiology, biochemistry, food safety, and technology, which are actively transferred to companies. She is the leader of several R&D projects within National and International Research Programs as well as with fresh-cut companies.

Speaker biographies Cont'd….

Leo van Overbeek, Wageningen University, The Netherlands

Senior scientist microbial ecology of plants at Wageningen UR, The Netherlands

Leo's interest is on the functioning, interaction and adaptation of microbial communities and individual populations in plant ecosystems.

Latest developments in his research groups were on isolation and identification of novel bacterial groups that live in association with plants. He has been involved in research on dissemination of pathogens belonging to the Borrelia species complex (emerging pathogens causing Lyme disease in humans) in Dutch natural ecosystems.

Currently, Leo leads on projects on microbial contaminants (*Escherichia coli*, EHEC, and *Salmonella enterica*) in vegetable crops, including technical developments in research innovation eg detection technologies, high throughput DNA sequencing (metagenomics) and bio-informatics.

Leo is also, the EU COST Action 16110 'HUPLANTcontrol' project lead. This project aims to establish a pan-European network of excellence among research groups, on the impact of plant microbiomes on human health. You will hear more on this project on day 2 of this event.

Mike Hutchison, Hutchison Scientific

I have worked as a food safety consultant microbiologist and research scientist for more than 25 years. I have an undergraduate degree in Biochemistry from the University of St Andrews and a PhD in plant-microbe interactions from the Plant Sciences department of the University of Cambridge. Previously I have worked as a research scientist for the cooperative extension grower support programme of the USDA, as a research microbiologist within the medical school at Edinburgh University and as senior consultant microbiologist for ADAS. Over the last 15 years I have been selft employed as a research scientist and food safety consultant. Over that time I have managed more than 30 research studies with a combined value of more than £8 million for the Food Standards Agency, Defra, the European Food Safety Authority and a number of commercial customers. The research has a general, common theme of improving food safety across a number of production sectors which includes fruit and fresh vegetables (FFV), white and red meats and the fish smoking sectors. For FFV, recent research studies have involved the survival of human pathogens in different soil types, on crops such as radish, carrot, leek and onion grown under commercially-relevant field conditions, the hygienic use of worker field latrines and washing facilities and the fate of enteric pathogens during the wholesale and retail distribution of washed produce. Currently, I am evaluating the effectiveness of electrolysed oxidised (EO) water as a seed treatment to reduce crop disease

Speaker biographies Cont'd….

Prof, Dr ir Mieke Uyttendaele
University of Gent, Belgium

Department of Food Technology, Food Safety and Health (BW23@FBW)
Research Unit Food Microbiology and Food Preservation research unit (FMFP-UGent)
Faculty of Bio-Science Engineering, Ghent University
www.ugent.be/bw/foodscience/en

Campus Coupure Blok B, Coupure Links 653, 9000 Gent, Belgium
Tel. +32 9 264 61 78, e-mail: mieke.uyttendaele@UGent.be

Mieke Uyttendaele is a leading scientist in the field of food hygiene and food safety with high experience in the microbial analysis of foods and the prevalence and behaviour of food borne pathogens from farm to fork.

Prof. Mieke Uyttendaele has a diploma of Bio-Science Engineering and Ph.D in Applied Biological Sciences (1996) from Ghent University, Belgium. She further pursued research as a postdoc of the Belgian National Fund of Scientific Research and now holds an academic position as Full Professor since 2004 situated at the Department of Food Technology, Food safety and Health at Ghent University in Belgium.

Her research area covers aspects of microbial analysis of foods (classical culture methods and rapid methods) and food safety including a wide variety of pathogens (*Campylobacter, Listeria monocytogenes*, pathogenic *E. coli*, *Salmonella*, foodborne viruses, *Bacillus cereus* etc.) and foods (poultry meat, fruits and vegetables and derived products, cooked chilled foods, etc). In the period 2010-2014 she was the coordinator of the EU FP7 Veg-i-Trade project looking into the impact of climate change and international trade on food safety of fresh produce.

For more information on her current research topics refer to https://www.ugent.be/bw/foodscience/en/research/faculty/miekeuyttendaele

Prof. Mieke Uyttendaele uses the knowledge on food borne pathogens and general food microbiology as the basis for input in microbial risk assessment. She is also main author of the book 'Microbiological Guidelines: Support for Interpretation of Microbiological Test Results of Foods' (die Keure publishing 2018, 478 pgs, ISBN 9782874035036).

Throughout her career she was/is the promotor of ca. 25 Ph.D students (including also various non-EU citizens) and has published more than 270 peer reviewed scientific papers and presented at numerous international Conferences/Workshops.
For a full biography refer to https://biblio.ugent.be/person/801000883868

She has been an ad hoc member of several EFSA panels' working groups and was a member of the Scientific Committee of the Belgian Food Safety Agency in period 2009-2017 and the Belgian Health Council. Currently she is member of COST Action 16110 – Control of Human Pathogenic Micro-organisms in Plant Production Systems (HUPLANTcontrol) (https://huplantcontrol.igzev.de/)

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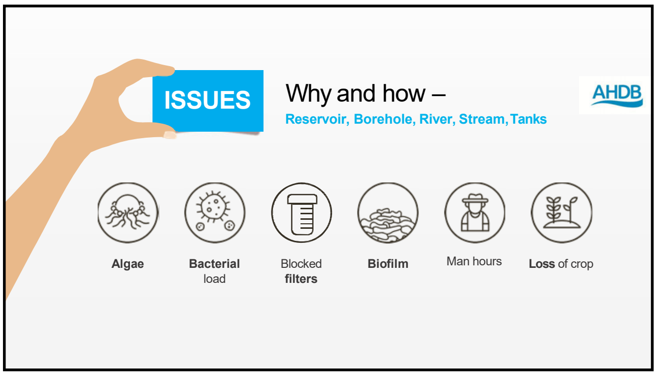
Al Sayed & Terri-Ann Boyle from IWS Ltd



Irrigation water disinfection - practical considerations
Al Sayed & Terri-Ann Boyle from IWS Ltd

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Understand your waters journey

before you start water treatment

Source of water → Storage → Time → Temperature → Filtration

→ Nutrients/feed → Irrigation lines → Water testing

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Water treatment – Current methods

Chlorine

Hydrogen Peroxide

UV systems

AHDB

Current methods – Pros & cons

Chlorine

⊕ Easy to obtain | Cost effective

⊖ **Produces trihalomethanes**

- Not environmentally friendly
- Struggles to deal with a high bacterial demand in high flow/stagnant waters
- Less effective at removing biofilm

Hydrogen peroxide

⊕ Good for flushing | Easy to obtain | Cost effective

⊖ Extremely **corrosive**

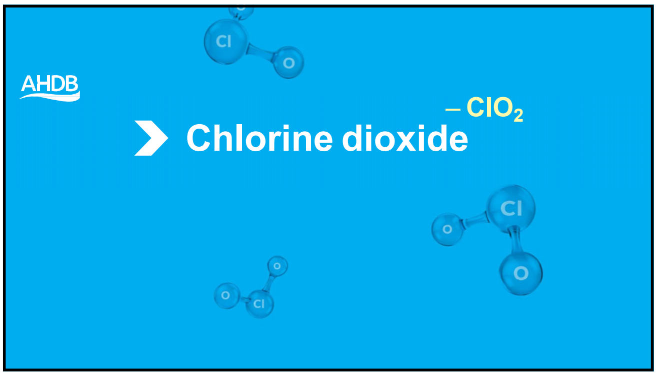
- Temperature dependant to achieve optimum kill
- Requires a higher concentration to be effective

UV systems

⊕ Effective kill rate on contact | Environmentally friendly

⊖ **Does not have residual values**

- Cannot cope with a high bacterial demand
- Expensive


AHDB
– ClO_2
Chlorine dioxide
Cl
O
Cl
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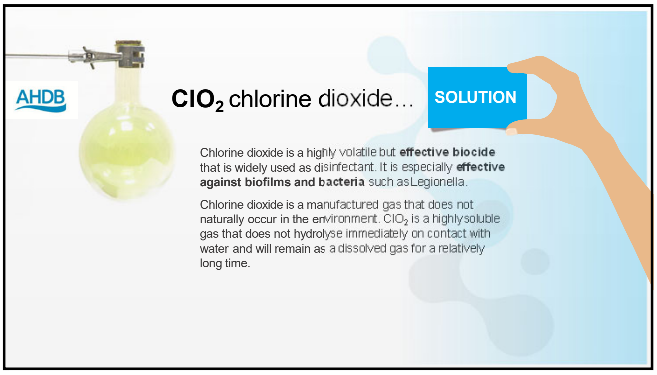
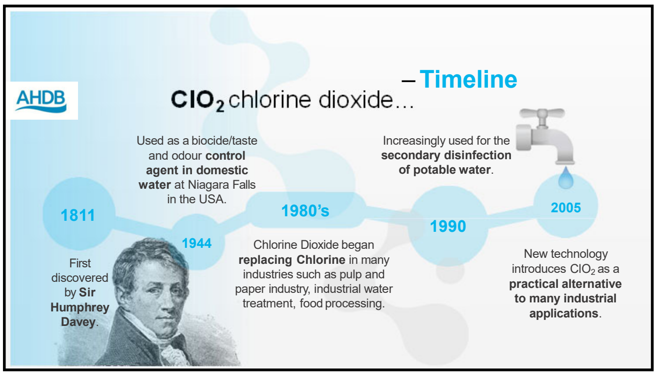
O
O
Cl
O


AHDB
ClO_2 chlorine dioxide…
SOLUTION
Chlorine dioxide is a highly volatile but effective biocide that is widely used as disinfectant. It is especially effective against biofilms and bacteria such as Legionella.
Chlorine dioxide is a manufactured gas that does not naturally occur in the environment. ClO_2 is a highly soluble gas that does not hydrolyse immediately on contact with water and will remain as a dissolved gas for a relatively long time.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ClO_2 chlorine dioxide… – Timeline
1811
First discovered by Sir Humphrey Davey.
1944
Used as a biocide/taste and odour control agent in domestic water at Niagara Falls in the USA.
1980's
Chlorine Dioxide began replacing Chlorine in many industries such as pulp and paper industry, industrial water treatment, food processing.
1990
Increasingly used for the secondary disinfection of potable water.
2005
New technology introduces ClO_2 as a practical alternative to many industrial applications.

Irrigation water disinfection - practical considerations
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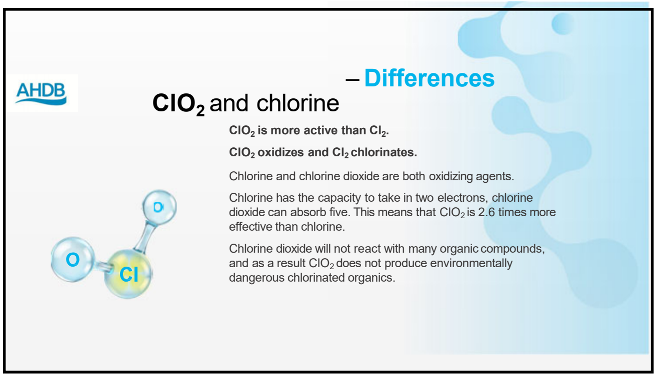
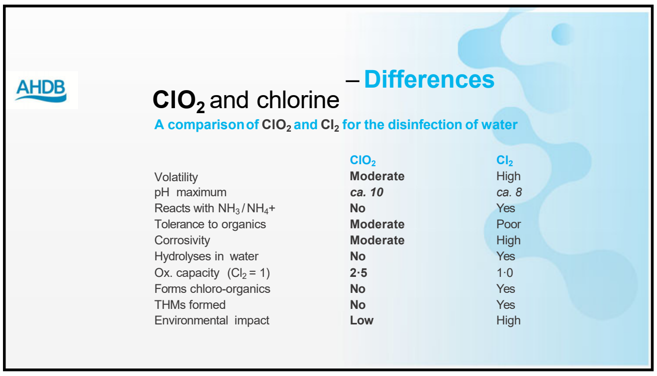
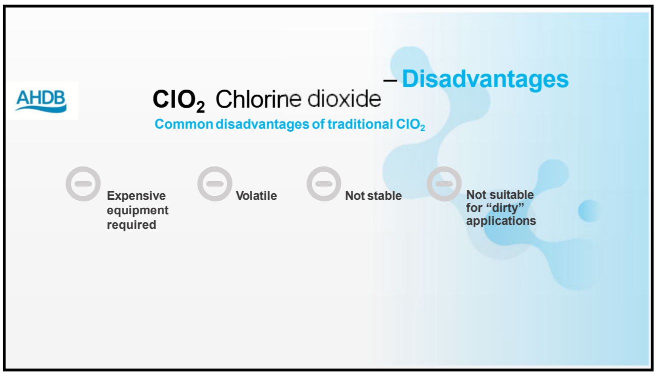
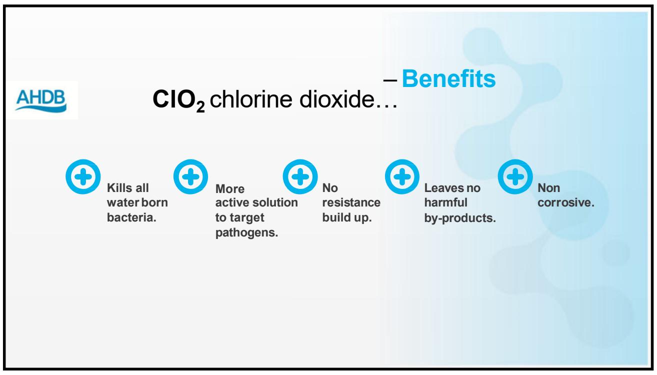
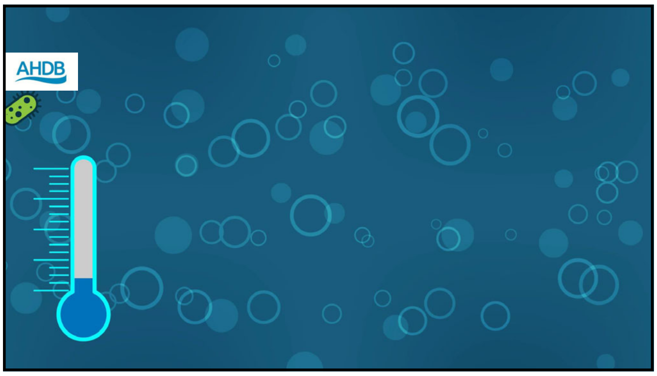
	Chlorine dioxide	HYDROGEN PEROXIDE (H_2O_2)	OZONE O_3	UV	FORMICACID	ORGANICACID	SODIUM HYPOCHLORITE, CHLORINE BLEACH
Decomposition Products	N ACL + H_2O	$H_2O + O_2$	O_2 + Oxygen ated Compunds	O_3	Carbon Mon oxide	Other Acids & Alkalis	Chlorie , Chlorin ated Hydrocarbons , Chloramines Chloroforms
Leaves Residues On Produce	NO	NO	NO	NO	YES	YES	YES
Declared On Label	NO	NO	NO	NO	NO	YES (food additive legislation)	NO
ProcessingAid	YES	YES	YES	YES	NO	NO	YES
Tainting Issues	NO	NO	NO	NO	YES	YES	YES
Reacts With Hydrocarbons	NO	YES	YES	YES	YES	YES	YES
SpecificTo Targeting Bacteria	YES	NO	NO	NO	NO	NO	NO
Operate In Turbid Water	YES	YES (will oxidise all organic matter)	YES (will oxidise all organic matter)	NO (water must be free from particulates)	YES	YES	YES (pH correction required)
General Oxidant	NO	YES	YES	YES	YES	NO (lowers pH)	YES
Hazardous In Use	NO	YES	YES	YES	YES	NO	YES
Corrosive	NO	YES	YES	NO	YES	NO	YES
Produce Harmful By-products	NO	YES	YES	YES	YES	NO	YES
100% Utilisation For Bacteria Kill	YES	NO	NO	NO	NO	NO	NO
Will Produce Chlorine	NO	NO	NO	NO	NO	NO	YES
Dwi Approved	YES	NO	NO	NO	NO	NO	NO






AHDB
ClO2 Chlorine dioxide – Disadvantages
Common disadvantages of traditional ClO2
Expensive equipment required
Volatile
Not stable
Not suitable for "dirty" applications


AHDB
ClO2 chlorine dioxide… – Benefits
Kills all water born bacteria.
More active solution to target pathogens.
No resistance build up.
Leaves no harmful by-products.
Non corrosive.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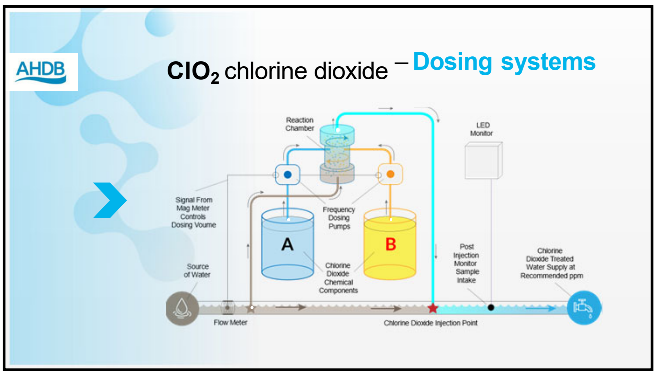
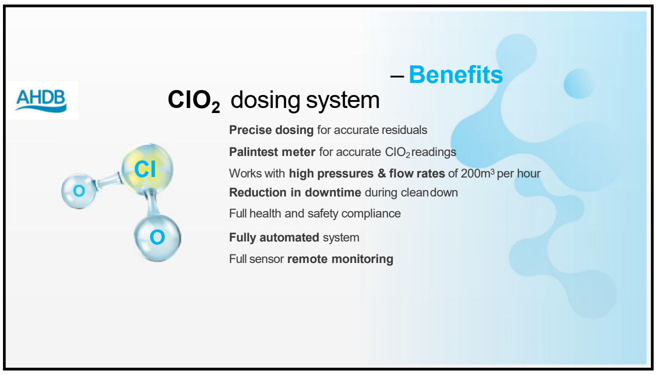

ClO_2 chlorine dioxide – Dosing systems
Reaction Chamber
LED Monitor
Signal From Mag Meter Controls Dosing Voume
Frequency Dosing Pumps
A
B
Chlorine Dioxide Chemical Components
Source of Water
Post Injection Monitor Sample Intake
Chlorine Dioxide Treated Water Supply at Recommended ppm
Flow Meter
Chlorine Dioxide Injection Point


ClO_2 dosing system – Benefits
Precise dosing for accurate residuals
Palintest meter for accurate ClO_2 readings
Works with high pressures & flow rates of 200m³ per hour
Reduction in downtime during cleandown
Full health and safety compliance
Fully automated system
Full sensor remote monitoring
Cl
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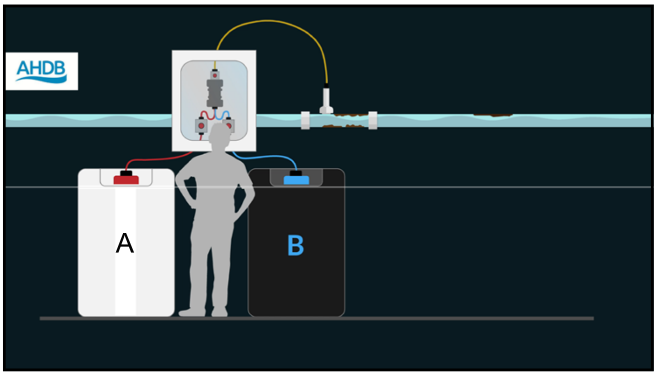
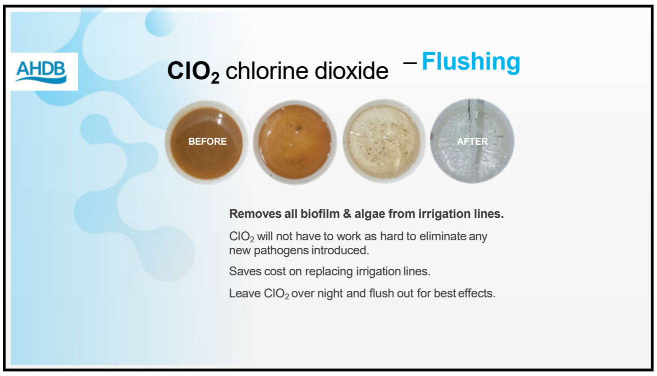
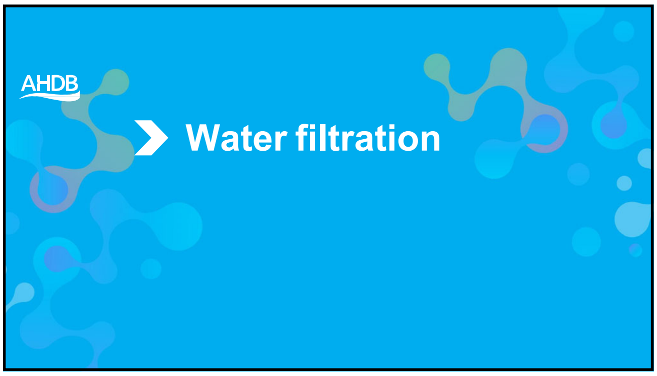
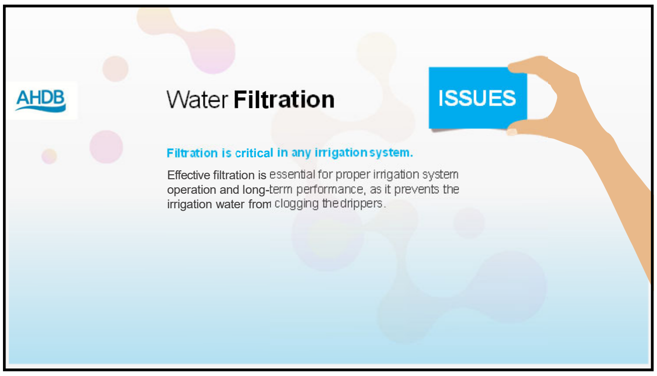

A
B

Irrigation water disinfection - practical considerations
Al Sayed & Terri-Ann Boyle from IWS Ltd







Irrigation water disinfection - practical considerations
Al Sayed & Terri-Ann Boyle from IWS Ltd

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Water Filtration – Disk filters

Disk Filters are used with surface water systems, wells or municipal water sources. These filters are comprised of a series of grooved plastic disks stacked together with a total equivalent screen size ranging from 40 to 400 mesh.

These filters enable deep three-dimensional filtering (e.g. allow entrapping of more particles as water passes through the pores created by the grooves in the surfaces of the filtering disks stacked together in the filter). **Having more surface area than screen filters, disk filters are better suited for higher flow rates.**

AHDB

Water Filtration – Screen filters

Screen filters are used mainly as secondary filters with surface water systems or as primary filters with well or municipal water sources. A screen filter is comprised of a cylinder with a net that traps the dirt.

This filter is intended for relatively clean water; its use is less common with water from a reservoir or pumped water.

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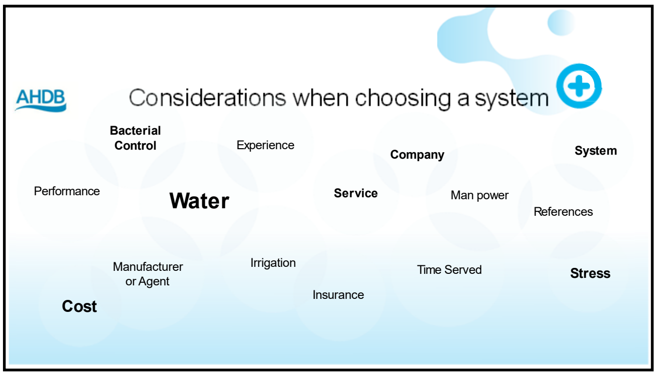
Let's not forget the objective

- No Bacteria/contaminants in irrigation water
- No blocked drippers
- No bacteria/contaminants on crop
- Easy to use – maintenance free

Keep it simple and effective


AHDB
Considerations when choosing a system
Bacterial Control
Experience
Company
System
Performance
Water
Service
Man power
References
Manufacturer or Agent
Irrigation
Time Served
Stress
Insurance
Cost


AHDB
Thank you. Any questions?
IWS
INTERNATIONAL WATER SOLUTIONS
INTERNATIONAL WATER SOLUTIONS LTD
IWS House, 1A Bates Industrial Estate
Church Road, Romford, Essex, RM3 0HU
UNITED KINGDOM
(0) 333 000 1111 info@iwatergroup.com

Harper Adams University

Managing risk in the production of UK fresh produce.

Dr Jim Monaghan

Overview

1. What fresh produce makes people sick?
2. Sources of risk in primary production
3. Requirements for risk assessment
4. Developing an evidence based approach

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Which crops are the greatest risk?

efsa
European Food Safety Authority

Ranking position	Pathogen	FoNAO category
First	*Salmonella* spp.	Leafy greens eaten raw as salads
Second	*Salmonella* spp.	Bulb and stem vegetables
	Salmonella spp.	Tomatoes
	Salmonella spp.	Melons
	Pathogenic *E. coli*	Fresh pods, legumes and grain
Third	Norovirus	Leafy greens eaten raw as salads
	Salmonella spp.	Sprouted seeds
	Shigella spp.	Fresh pods, legumes or grain
Fourth	*Bacillus* spp.	Spices and dry powdered herbs
	Norovirus	Bulb and stem vegetables
	Norovirus	Raspberries
	Salmonella spp.	Raspberries
	Salmonella spp.	Spices and dry powdered herbs
	Salmonella spp.	Leafy greens mixed with other fresh FoNAO
	Shigella spp.	Fresh herbs
	Pathogenic *E. coli*	Sprouted seeds
	Yersinia spp.	Carrots
Fifth	Norovirus	Tomatoes
	Norovirus	Carrots
	Salmonella spp.	Nuts and nut products
	Shigella spp.	Carrots

EFSA (2013)

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Produce associated with food borne illness *probably or definitely* linked to field contamination

Leafy crops
- salad onions
- lettuce
- spinach
- rocket
- parsley
- watercress
- coriander
- basil
- cabbage (coleslaw)

The rest…
- apple (juice)
- strawberries
- raspberries
- blueberries
- carrots
- cucumber
- tomato
- melon
- peas (mangetout)

Harper Adams University

The risk is small but can be serious when it goes wrong

Comparison of reported foodborne outbreaks of non-animal and animal origin 2007-2011 (EFSA,2013)

	Outbreaks	Cases	Hospitalisation	Deaths
All data	10%	26%	35%	46%
Excl. 2011 vtec O104 outbreak	10%	18%	8%	5%

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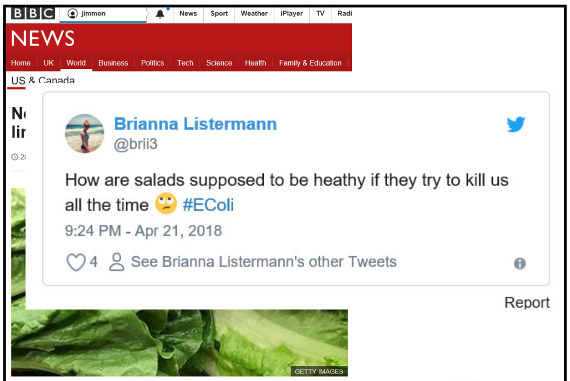


US health officials are investigating a major E. coli outbreak involving romaine lettuce that has already affected 98 people in 22 states.

Harper Adams University


Vox

No one should die from eating salad

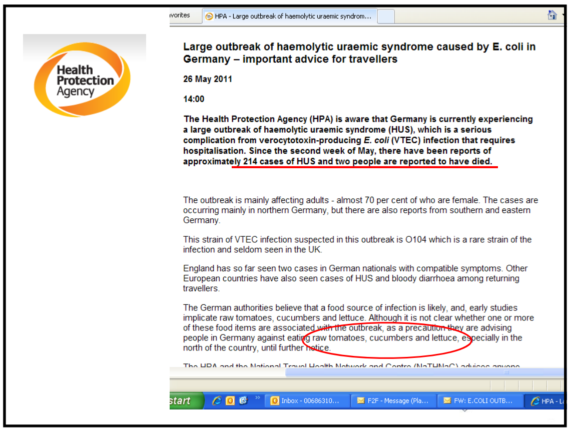
Five people died from eating romaine lettuce in the past four months. Is the convenience of packaged salad worth the risk?

By Julia Belluz | @juliaoftoronto | julia.belluz@voxmedia.com | Jun 4, 2018, 2:40pm EDT

"When you bag and chop [salad], bacteria just gets amplified — and when you ship it across the country, the bacteria has a chance to grow in the bag," said Bill Marler, a food safety attorney. | Justin Sullivan/Getty Images

No one should die from eating a salad. But over the past four months, five people have died and 197 have fallen ill across the country as a result of E. coli infections linked to romaine lettuce, most of it sold chopped and bagged.

MOST READ


Health Protection Agency

HPA - Large outbreak of haemolytic uraemic syndrom...

Large outbreak of haemolytic uraemic syndrome caused by E. coli in Germany – important advice for travellers

26 May 2011

14:00

The Health Protection Agency (HPA) is aware that Germany is currently experiencing a large outbreak of haemolytic uraemic syndrome (HUS), which is a serious complication from verocytotoxin-producing *E. coli* (VTEC) infection that requires hospitalisation. Since the second week of May, there have been reports of approximately 214 cases of HUS and two people are reported to have died.

The outbreak is mainly affecting adults - almost 70 per cent of who are female. The cases are occurring mainly in northern Germany, but there are also reports from southern and eastern Germany.

This strain of VTEC infection suspected in this outbreak is O104 which is a rare strain of the infection and seldom seen in the UK.

England has so far seen two cases in German nationals with compatible symptoms. Other European countries have also seen cases of HUS and bloody diarrhoea among returning travellers.

The German authorities believe that a food source of infection is likely, and, early studies implicate raw tomatoes, cucumbers and lettuce. Although it is not clear whether one or more of these food items are associated with the outbreak, as a precaution they are advising people in Germany against eating raw tomatoes, cucumbers and lettuce, especially in the north of the country, until further notice.


FOOD manufacture

Deadly norovirus found in one-in-20 lettuces

By Noli Dinkovski
17-Dec-2018 - Last updated on 17-Dec-2018 at 17:46 GMT

Of the 568 samples of lettuce examined, 30 were shown to be norovirus-positive

Bristol Post

TUE 8.4 °C Cloudy

News | Sport | What's On | Jobs | Property | Motors | Directory | Notices | Buy&

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Huge outbreak of E. Coli caused by eating salad making dozens of people in Bristol area sick

By S_Prideaux | Posted: July 04, 2016

Share | Tweet | Share | Email | 0 COMMENTS | 72 SHARES

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But not many die – so what?

- 10 – 100 x more get sick but are not traced.
- Are sick customers going to buy your product again, soon??

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Commercial consequence of food safety issues!

Know your enemy

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Main culprits

- *Salmonella*
- *E. coli* O157 (and other VTEC)
- Norovirus
- *Listeria*

- Main route is faecal – oral
- THE PROBLEM IS *MAINLY* POO

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FACTSHEET 13/10
Cross sector
AHDB
Monitoring microbial food safety of fresh produce

Other pathogens?

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What are the risks

(OR ARE THEY HAZARDS)?

Hazard vs Risk

http://www.reidmiddleton.com/reidourblog/hazards-vs-risks-whats-the-difference/

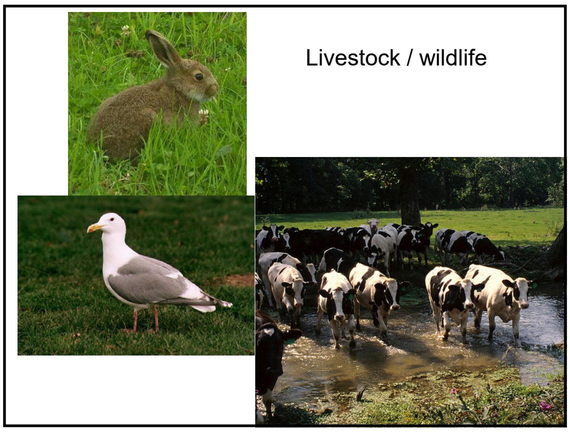
Hazard v Risk

Hazard = What can go wrong
e.g. pathogen in manure contaminates leafy crop via irrigation water

Risk = likelihood
e.g. water is applied through drip tape at base of plant OR water is applied onto the leaves


Water


Soil & manures


Livestock / wildlife

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Is irrigation water a risk?

Routes of direct crop contamination through irrigation water

Irrigation event

↓

Contaminated leaf surface

↓

Consumer risk

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US work

- *E. coli* O157:H7 applied through irrigation can persist on the surface of lettuce for 77 days (Islam *et al*., 2004a).
- *Salmonella enterica* Typhimurium as persisting on leaves of lettuce for 63 days (Islam *et al*., 2004b).

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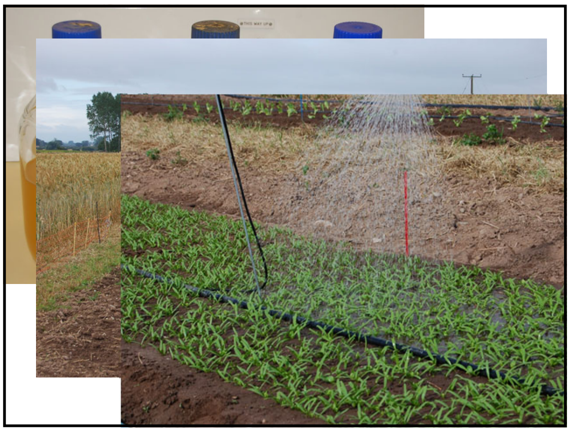
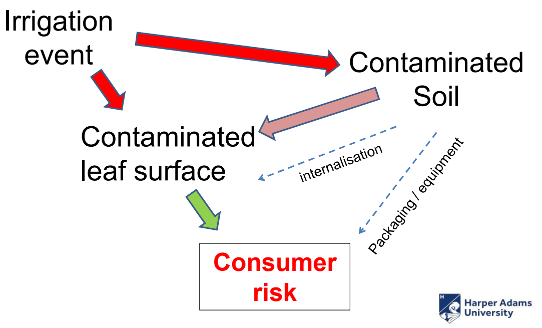


Number of weeks for zoonotic agents to decline on leaves <10 CFU g^{-1}

		Early		Mid		Late	
		Low	High	Low	High	Low	High
Salmonella Enteriditis	Lettuce	1.0	1.3	1.3	1.3	1.0	1.3
	Spinach	1.0	1.3	1.3	1.7	1.3	1.7
E. coli O157	Lettuce	1.0	1.3	1.7	2.0	1.0	1.0
	Spinach	1.0	1.0	2.0	2.0	1.7	1.0
Campylobacter jejuni	Lettuce	1.0	1.0	1.3	2.0	1.0	1.0
	Spinach	1.0	1.0	2.0	2.0	1.0	1.0

Routes of direct crop contamination through irrigation water



US work

- *E. coli* O157:H7 persist in soils for around 200 days (Islam *et al*. 2004a; Islam *et al*. 2005).
- *Salmonella enterica* Typhimurium for 161 days (Islam *et al*. 2004b).

Zoonotic agents persist longer in soils than on leaf surfaces (wks to absence)

		Late season	
		Low	High
Salmonella enteriditis	Soil A	>6	>6
	Soil B	>6	>6
	Lettuce	2	2
	Spinach	2	3
E. coli O157	Soil A	>6	>6
	Soil B	>6	>6
	Lettuce	2	3
	Spinach	3	3
Campylobacter jejuni	Soil A	>6	>6
	Soil B	>6	>6
	Lettuce	3	3
	Spinach	3	3

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Soil splash as a risk

- Zoonotic agents persist in soil longer than leaves
- Surface soil is splashed during rain/irrigation


Journal of Applied Microbiology
Journal of Applied Microbiology ISSN 1364-5072

ORIGINAL ARTICLE

Distribution and decline of human pathogenic bacteria in soil after application in irrigation water and the potential for soil-splash-mediated dispersal onto fresh produce

J.M. Monaghan[1] and M.L. Hutchison[2]

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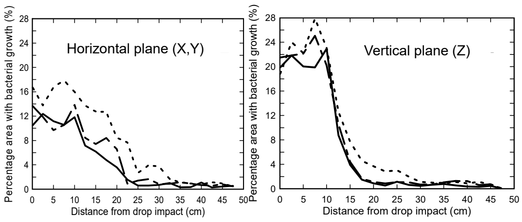
Droplet size

- Commercial sprinklers generate droplets over the range of 0.5 – 4 mm (Kay 1983; Kincaid *et al*. 1996).
- Majority of rain drops are ≤ 4 mm (e.g. Williams *et al*. 2000).
- Thunderstorms produce larger raindrops.

Water drops splash bacteria 20-30 cm Large droplets distribute bacteria further



Drop volumes were 24 µl (solid line) 56 µl (long and short dashes) and 87 µl (short dashes)

Conclusions

1. Zoonotic agents persist for relatively short time on the surface of leaves during UK season <2 weeks
2. Zoonotic agents can persist in soil for > 6 weeks where conditions are cool and damp (end of season is greatest risk)
3. Zoonotic agents persist for shorter time in higher organic matter soils
4. Soil splash can disperse bacteria 20-30 cm and needs to be considered.

The 'dream' is drinking water quality for irrigation

- Problems
  - Rare in field environment
  - Variable water sources
  - Too expensive?

  - Water is not the only problem
  - Soil contamination etc from external environment

So how do growers know their water is safe to use for irrigation?

- Small scale testing
  - Limited 'guarantee' from a statistical perspective
- Compliance with food safety QAS/ CoP

WHO standards

- In 1989 standard was set as
  ≤1000 cfu/100 mL faecal coliforms
  ≤1/L intestinal nematode during the irrigation period.

- Now **<u>no definitive WHO values</u>** for microbiological guidelines for irrigation water.
- "water guidelines in advanced economies should rely on in-country standards"

Regulation (EC) No 852/2004 on the hygiene of foodstuffs (1)

- Potable water = Drinking water
  - "meeting the minimum requirements laid down in Council Directive 98/83/EC [38] on the quality of water intended for human consumption"
  - Chemical
  - Radiation
  - Micro levels

Microbiological parameters

Parameter	Parametric value
Escherichia coli (E. coli)	0 in 250 ml
Enterococci	0 in 250 ml
Pseudomonas aeruginosa	0 in 250 ml
Colony count 22°C	100/ml
Colony count 37°C	20/ml

Regulation (EC) No 852/2004 Definition of 'Clean Water'

- "natural, artificial or purified […] brackish water that does not contain micro-organisms, harmful substances […] in quantities capable of directly or indirectly affecting the health quality of food".
- Specific microbiological criteria are not defined
- Growers must be able to demonstrate that their operations are managed in a way that controls food safety risks.

Codex

Baseline 'guidance' is from *Codex Alimentarius*

- *General Principles of Food Hygiene* – CAC/RCP 1-1969
- Code of hygienic practice for fresh fruit and vegetables – CAC/RCP 53-2003
- "*general framework of recommendations […] rather than providing detailed recommendations for specific agricultural practices…*"

1. It must be safe

Leafy Green annex of the Code of hygienic practice for fresh fruit and vegetables- CAC/RCP 53–2003

Microbial requirements are not defined.

- "*seek appropriate guidance on water quality and delivery methods to minimize the potential for contamination with microbial pathogens*"

Water in contact with edible portion (i.e. leaves) "*should meet the standards for potable or clean water*"

- Potable water – WHO standards
- Clean water – water that does not compromise food safety in the circumstances of its use.

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When is the risk greatest – and can it be managed?

Potential vectors and routes of faecal contamination and the stages in production when the hazard may be present.

Vector	Route of contamination	Growing	Harvest	Primary Processing	Storage and Transport
Water	Irrigation	X			
	Cooling systems			X	X
	Wash water			X	
	Flooding	(X)			
Soil	Manure based soil amendments	X			
Livestock	Farmed livestock in rotation	X			X
	Incursion by farmed livestock	(X)			
	Wildlife/pests	(X)			X
Surfaces	Workers	X	X	X	X
	Equipment		X	X	X

X = managed inputs
(X) = unmanaged inputs

Monaghan et al., 2017 JFP

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You need to manage controlled and uncontrolled hazards

That's OK I'll do some

RISK ASSESSMENTS

RISK ASSESSMENT OR ASSESSMENT OF RISK?

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Codex - Risk Assessment

A scientifically based process consisting of four steps:

1. hazard identification
2. hazard characterization
3. exposure assessment
4. risk characterization

Codex - Risk Assessment

A scientifically based process consisting of four steps:

1. hazard identification
2. ~~hazard characterization~~
3. exposure assessment
4. ~~risk characterization~~

GlobalGAP – Risk Assessment

Annex AF1 defines five steps for RA as:

1. identify the hazards;
2. decide who/what might be harmed and how;
3. evaluate the risks and decide on precautions;
4. record the work plan/findings (and implement them);
5. review the assessment and update if necessary.

Are primary producers basing decisions on opinions and hopes?

How are primary producers JUSTIFYING assessments of risk?

1. Potential exposure of crop to contamination
2. Effectiveness of single interventions
3. Effectiveness of multiple interventions (Hurdles)

- Where is the evidence to justify decisions?
  - academic papers are not suited to use by the industry.
  - no direct scientific studies quantifying the effect of hurdle technology approach in the field.
  - Reliance on best practice and expert opinion

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Can we develop an evidence based assessment of risk?

Practical RA
- Hazard ID
- Exposure assessment
- Intervention assessment
- Exposure assessment following intervention

Evidence
- Generic risk of faecal contamination
- Monitoring of indicators; scientific reports; industry guidelines
- Scientific studies; industry guidelines
- Monitoring of indicators (*E.coli* – EFSA, 2014)?

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Scenario – irrigation water source for a leafy salad crop

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Winter storage irrigation reservoir

- Open water source
- No water treatment

- **Hazard ID**

Generic hazard is faecal contamination.

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Potential Exposure assessment

Probability descriptors to classify likelihood that contamination can occur at levels associated with human illness.

Probability category	Interpretation
Negligible	So rare that it does not merit to be considered
Very low	Very rare but cannot be excluded
Low	Rare, but does occur
Medium	Occurs regularly
High	Occurs very often
Very high	Events occur almost certainly

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Potential Exposure assessment = *Medium*

Evidence

- Water testing programme (5 years)
- 10-850 cfu *E.coli*/100 ml
- >100 cfu E.coli/100 ml (RTFP)
- Exceeding indicator levels intermittently showing that the faecal contamination of the water **occurs regularly**

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Intervention assessment

Definition

- **Effective** = validated reduction to give a consistently negligible exposure risk.
- **Partially Effective** = non-validated reduction where it is possible that the exposure risk may not be reduced consistently to negligible levels.

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Avoiding leaf contact by using drip tape to apply the irrigation

Intervention assessment = Partial

Evidence
- Avoiding contact with the leaf is a suggested intervention (GlobalGAP, 2015)
- Soil splash of contaminated soil can occur (Monaghan and Hutchison, 2012)
- **Contamination could still occur**.

Stopping irrigation 7 days before harvest

Intervention assessment = Partial

Evidence
- Bacteria rapidly decline on the leaves of lettuce in warm dry conditions (Hutchison et al, 2008).
- Bacteria can persist in cooler conditions (Islam et al, 2004a).
- **Contamination could still occur**.

How to assess multiple partial interventions?

- Assumed synergy, or even a multiplicative interaction, between combinations of partial treatments, with different modes of action.
- Hurdle effect (Leistner, 2000).
- Multiple partial interventions are recommended (e.g. Red Tractor).
- Few studies into the effect of a hurdle technology approach in leafy crop production.

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How do you know it is safe?

Evidence

- Partial reduction of risk x 2
- NO EVIDENCE of level of actual or relative reduction as conditions specific to growing location.
- **Monitor water and harvested crop using E.coli as a hygiene criteria (EFSA,2014)?**
- ***Change water source?***

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Evidence is hard for growers to access

- Evidence base = scientific literature, databases in the food industry, government agencies, international organizations and opinions of experts (CAC, 2003)
- Historic microbiological sampling data.
- Manufacturers or suppliers of equipment may provide evidence of effectiveness of processes such as water treatment.
- *E. coli* based hygiene criterion for leafy greens at pre-harvest, harvest or on farm post-harvest (EFSA,2014)

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Developing an evidence based assessment of risk

1. Production of crops that are eaten uncooked has few or no 'true' CCPs.
2. Growers need to justify decisions in Risk Assessments in a structured decision process.
3. Evidence base is needed for primary producers.
   - Where will it come from?
4. Move towards increased use of hygiene indicators?

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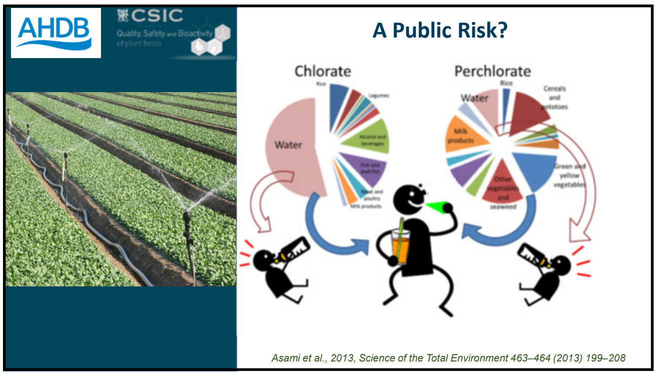
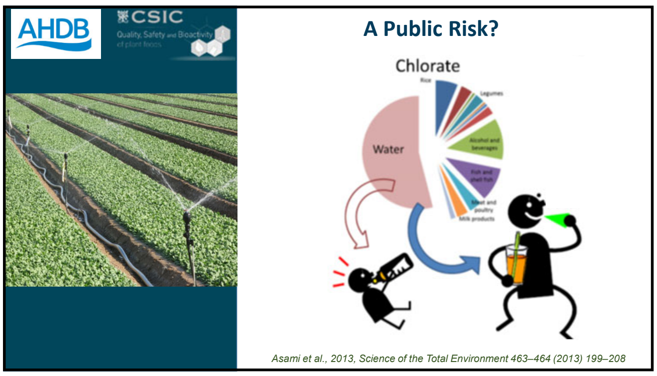
Fresh Produce is Good For You!

Harper Adams University

Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

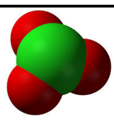




Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

AHDB | CSIC Quality, Safety and Bioactivity of plant foods

Chlorate



What we know?

1. Chlorate is a substance that is no longer approved as a pesticide according to Commission Decision No 2008/865/EC.
2. High concentrations of chlorate found in fruits and vegetables linked to the **use of chorine based water disinfection treatments**
3. **Chlorate is formed as a by-product when using chlorine, chlorine dioxide or hypochlorite**
4. Chlorate residues have a tendency to concentrate, resulting in residues in food.
5. **A tolerable daily intake (TDI) of 3 µg chlorate/kg body weight (b.w.)** was set by read-across from a TDI of 0.3 µg/kg b.w. derived for this effect for perchlorate, multiplied by a factor of 10 to account for the lower potency of chlorate.
6. Based on that TDI, **a guideline level of 0.7 mg/L chlorate in drinking water** has been established

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EFSA's scientific advice was requested to support decision-makers in the Commission and Member States who are re-examining existing measures to limit consumer exposure to chlorate in food. When considering efforts to reduce chlorate residues in food, besides the toxicological aspects of these residues, the impact on microbiological food safety should also be taken into account. EFSA did not, however, evaluate these aspects as part of this risk assessment.

https://ferpasherpa.org/policymakers/

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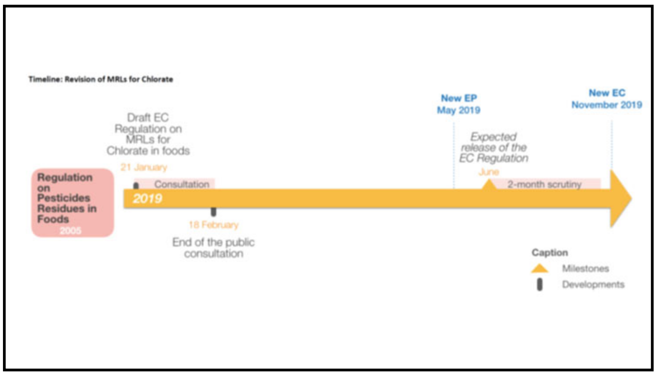
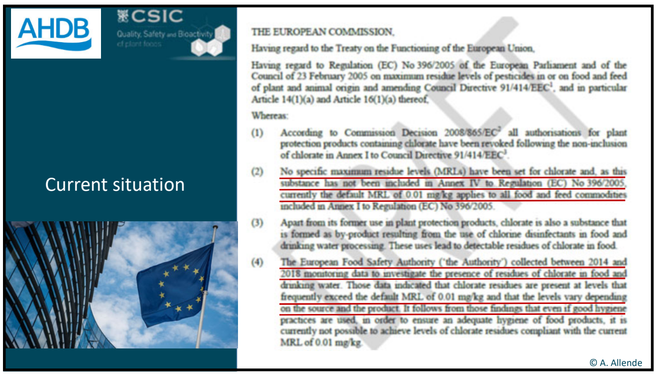
Background	Status-quo and next steps in the political calendar	Key stakeholders
- On 21 January 2019, the EC opened a 4-week consultation on a draft Commission Regulation on the revision of Maximum Residue Limits (MRLs) for chlorate in food under Regulation (EC) 396/2005, which sets MRLs of pesticides in food products. - The Annex to the Regulation proposes the following MRLs for fruits used in juices: • 0.01 mg/kg for tomatoes and other fruiting vegetables; • 0.02 mg/kg for citrus fruits, tree nuts, pome fruits, stone fruits; (rev.7 - 0.05 mg/kg) • 0.03 mg/kg for berries and small fruits, fruits with edible and inedible peel; (rev.7 - 0.05 mg/kg) • 0.08 mg.kg for cucurbits with inedible peel (melon, watermelons). - Answering the question of MEP Dimitrios Papadimoulis (on 4 April 2019), Commissioner Jyrki Katainen confirmed the EC intends to release its evaluation report on the pesticide residues regulation in 2019.	**Status-quo:** - The consultation closed on 18 February 2019. The Commission received feedback from 64 stakeholders. - WG meeting of experts (13.05.2019) - a footnote will be included for fruit juices setting a limit of 0.1 mg/kg + a new approach has been raised, note (A) for all the processed food (no need to regulate chlorate). EFSA is expected to reveal data which was used to set the limits by mid-June. - Cross-sectoral letter sent to the VP Katainen - After SCoPAFF meeting (13-14 June 2019) – new, acceptable wording of the note (A) has been presented. Some MRLs has been raised. - On 1 July 2019 Letter to Mr Berend (DG ... for fruit juices (MRL= 0.1 mg/kg) has been sent. - In Mr Berend reply from 10/07/2019 is stated that if amended note (A) is legally acceptable, it may be possible to remove the specific footnote "(+) 0.1 mg/kg" for fruit juices. - In rev. 8 the specific footnote "(+) 0.1 mg/kg" for fruit juices has been removed and the wording of the note (A) is satisfactory for us. - 26-27 September 2019 - SCoPAFF – the foreseen vote has been postponed.	**Institutional stakeholders:** - **EC:** [illegible], DG SANTE Unit E.4 - **Council:** Member State representatives **Non-institutional stakeholders:** - European Food Safety Authority (EFSA) - FoodDrinkEurope - Culinaria Europe - Copa-Cogeca - EuroCommerce - European Consumer Organisation (BEUC) - TomatoEurope - European Dairy Association (EDA) - Fresh Produce Consortium - Food & Biocides Industry Group - Freshfel Europe

SCoPAFF: Standing Committee on Plants, Animals, Food and Feed

Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain





Where are we on chlorate and perchlorate?

Ana Allende, CEBAS-CSIC, Spain

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Current situation

(8) It is therefore appropriate to set temporary MRLs for chlorate according to the ALARA principle ('as low as reasonably achievable') at the level corresponding to the 95th percentile of the occurrence data reflecting levels that are realistically achievable when good manufacturing practices are used. The temporary MRLs should be reviewed within five years of publication of this Regulation in the light of further progress made by food business operators to bring chlorate levels down, or whenever new information and data become available that would warrant an earlier review.

(9) The Commission consulted the European Union reference laboratories on appropriate limits of determination (LODs) for chlorate residues in certain specific commodties.

(10) Based on the scientific opinion of the Authority and taking into account the factors relevant to the matter under consideration, the proposed MRLs fulfil the requirements of Article 14(2) of Regulation (EC) No 396/2005.

(11) Regulation (EC) No 396/2005 should therefore be amended accordingly.

(12) The measures provided for in this Regulation are in accordance with the opinion of the Standing Committee on Plants, Animals, Food and Feed.

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Home > News > New maximum residue levels for chlorate proposed

New maximum residue levels for chlorate proposed

The European Commission has set out its proposal for new chlorine maximum residue levels (MRLs) for edible fresh produce.

January 2020

SANTE 10684-2015
on 22/11/2018 09:04

Chlorate — January 2019

	code	Commodities	Current	New
1	0100000	FRUITS, FRESH or FROZEN; TREE NUTS		
2	0110000	Citrus fruits		0.02
4	0110010	Grapefruits		0.02
2	0210000	Root and tuber vegetables		
3	0211000	(a) potatoes		0.02
3	0212000	(b) tropical root and tuber vegetables		0.03
3	0213000	(c) other root and tuber vegetables except sugar beets		
4	0213010	Beetroots		0.03
4	0213020	Carrots		0.1
2	0230000	Fruiting vegetables		
3	0231000	(a) Solanaceae and Malvaceae		
4	0231010	Tomatoes		0.1
4	0231020	Sweet peppers/bell peppers		0.3
4	0231030	Aubergines/eggplants		0.25
4	0231040	Okra/lady's fingers		0.1
5	0231990	Others (2)		0.1
3	0232000	(b) cucurbits with edible peel		0.25
4	0232010	Cucumbers		0.25
4	0232020	Gherkins		0.25
4	0232030	Courgettes		0.25
5	0232990	Others (2)		0.25
3	0233000	(c) cucurbits with inedible peel		0.08

Where are we on chlorate and perchlorate?

Ana Allende, CEBAS-CSIC, Spain

SANTE/10684/2015, Rev. 6 D059760/03	January 2020
[AnnexIIIA] Pesticide residues and maximum residue levels (mg/kg)	**CHLORATES**
VEGETABLES, FRESH or FROZEN	
Bulb vegetables	
Garlic	**0.7**
Onions	**0.5**
Shallots	**0.05**
Spring onions/green onions and Welsh onions	**0.05**
Others (2)	**0.05**
Fruiting vegetables	
(a) Solanaceae and Malvaceae	
Tomatoes	**0.1**
Sweet peppers/bell peppers	**0.3**
Aubergines/eggplants	**0.4**
Okra/lady's fingers	**0.1**
Others (2)	**0.1**

SANTE 10684-2015
on 22/11/2018 09:04

Chlorate
January 2019

	code	Commodities	Current	New
2	0240000	Brassica vegetables (excluding brassica roots and brassica baby leaf crops)		
3	0241000	(a) flowering brassica		
4	0241010	Broccoli		0.45
4	0241020	Cauliflowers		0.06
2	0250000	Leaf vegetables, herbs and edible flowers		
3	0251000	(a) lettuces and salad plants		0.15
4	0251010	Lamb's lettuces/corn salads		0.15
4	0251020	Lettuces		0.15
4	0251030	Escaroles/broad-leaved endives		0.15
4	0251040	Cresses and other sprouts and shoots		0.15
4	0251050	Land cresses		0.15
4	0251060	Roman rocket/rucola		0.15
4	0251070	Red mustards		0.15
4	0251080	Baby leaf crops (including brassica species)		0.15
5	0251990	Others (2)		0.15
3	0252000	(b) spinaches and similar leaves		0.15
4	0252010	Spinaches		0.15

SANTE/10684/2015, Rev. 6 D059760/03	January 2020
[AnnexIIIA] Pesticide residues and maximum residue levels (mg/kg)	**CHLORATES**
VEGETABLES, FRESH or FROZEN	
Leaf vegetables, herbs and edible flowers	**0.7**
(a) lettuces and salad plants	
Lamb's lettuces/corn salads	
Lettuces	
Escaroles/broad-leaved endives	
Cresses and other sprouts and shoots	
Land cresses	
Roman rocket/rucola	
Red mustards	
Baby leaf crops (including brassica species)	
Others (2)	
(b) spinaches and similar leaves	
Spinaches	
Purslanes	
Chards/beet leaves	

Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

SANTE/10684/2015, Rev. 6 D059760/03 [AnnexIIIA] Pesticide residues and maximum residue levels (mg/kg)	January 2020
Brassica vegetables(excluding brassica roots and brassica baby leaf crops)	
(a) flowering brassica	
Broccoli	**0.4**
Cauliflowers	**0.06**
Others (2)	**0.06**
(c) other root and tuber vegetables except sugar beets	
Beetroots	**0.05**
Carrots	**0.15**

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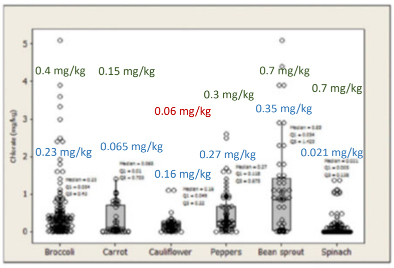
Leaf vegetables, herbs and edible flowers	0.7
(a) lettuces and salad plants	
Brassica vegetables(excluding brassica roots and brassica baby leaf crops)	
(a) flowering brassica	
Broccoli	0.4
Cauliflowers	0.06
Others (2)	0.06
(c) other root and tuber vegetables except sugar beets	
Beetroots	0.05
Carrots	0.15
Bulb vegetables	
Garlic	0.7
Onions	0.5
Shallots	0.05
Spring onions/green onions and Welsh onions	0.05
Others (2)	0.05
Fruiting vegetables	
(a) Solanaceae and Malvaceae	
Tomatoes	0.1
Sweet peppers/bell peppers	0.3
Aubergines/eggplants	0.4
Okra/lady's fingers	0.1
Others (2)	0.1

Reachable?



Kettlitz et al., (2016): Why chlorate occurs in potable water and processed foods: a critical assessment and challenges faced by the food industry, Food Additives & Contaminants: Part A

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Leaf vegetables, herbs and edible flowers	0.7
(a) lettuces and salad plants	
Brassica vegetables(excluding brassica roots and brassica baby leaf crops)	
(a) flowering brassica	
Broccoli	0.4
Cauliflowers	0.06
Others (2)	0.06
(c) other root and tuber vegetables except sugar beets	
Beetroots	0.05
Carrots	0.15
Bulb vegetables	
Garlic	0.7
Onions	0.5
Shallots	0.05
Spring onions/green onions and Welsh onions	0.05
Others (2)	0.05
Fruiting vegetables	
(a) Solanaceae and Malvaceae	
Tomatoes	0.1
Sweet peppers/bell peppers	0.3
Aubergines/eggplants	0.4
Okra/lady's fingers	0.1
Others (2)	0.1

Reachable?

Table 5. Chlorate content of selected prepared vegetables (frozen, unless otherwise specified).

Vegetable	Number of samples	Positive (%)[a]	Range (mg kg⁻¹)	Average (mg kg⁻¹)[b]	
Paprika	20	100	0.07–2.6	0.75	
Artichoke	7	100	0.01–0.29	0.123	
Bean sprouts	50	96	< 0.01–5.1	1.045	0.7 mg/kg
Broccoli	195	94	< 0.01–5.1	0.436	
Peppers (green, red, yellow, sweet)	77	92	< 0.01–2.6	0.48	0.3 mg/kg
Cauliflower	71	92	< 0.01–1.1	0.167	0.06 mg/kg
Leek	21	91	< 0.01–3.36	0.6	
Aubergine	7	86	< 0.01–1.3	0.497	0.4 mg/kg
Onion	33	82	< 0.01–0.698	0.167	
Peas	69	68	< 0.01–1.41	0.239	
Carrot	52	67	< 0.01–1.41	0.261	
Spinach	144	60	< 0.01–1.38	0.171	0.7 mg/kg
Tomato (paste and purée)	24	58	< 0.01–0.186	0.039	
Cabbage (white, red, Savoy)	14	57	< 0.01–0.1	0.0175	
Courgette/zucchini	34	50	< 0.01–1.63	0.272	
Green beans (frozen or purée)	14	43	< 0.01–0.07	0.019	
Potato[c]	49	27	< 0.01–0.12	0.016	
Pumpkin[c]	16	25	< 0.01–0.09	0.016	
Zucchini (flakes)	9	22	< 0.01–0.21	0.03	

Notes: [a]Above 0.01 mg kg⁻¹.
[b]Of all samples, if < LOQ then 0.5 LOQ allocated.
[c]Frozen, diced, dried, purée or flaked.

Kettlitz et al., (2016): Why chlorate occurs in potable water and processed foods: a critical assessment and challenges faced by the food industry, Food Additives & Contaminants: Part A

Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

EU chlorates debate to extend into 2020

By Rod Addy
12-Nov-2019 - Last updated on 12-Nov-2019 at 16:36 GMT

2 POST A COMMENT

Proposals concerning chlorates in food and drinking water are to extend in to 2020

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Current situation

European Commission (EC) proposals concerning chlorates in food and drinking water look set to be debated into 2020, according to chief executive of the Chilled Food Association Kaarin Goodburn.

EC lawyers are rejecting arguments that chlorate traces should be classed as contaminant rather than 'plant protection product'. However, the proposals do recognise such traces arise from hygiene biocides used for food safety.

Maximum residue levels have now been proposed for various commodities, including meat, fruit and veg, cereals, milk, plus processed foods.

The proposal aims to allow for chlorate arising from hygiene controls in defined processed foods, excluding frozen commodities and ready-to-eat salads. Under the new rules, food business operators would have to prove chlorates in processed food samples were from legitimate inputs, not pesticides.

The EU Standing Committee on Plants Animals Feed and Food is expected to formally vote on proposals after a new Commission is formed.

PAFF Committees

Standing Committees deliver opinions that inform the Commission's work on measures that it is planning. Such measures relate to the implementation of legislation that is already adopted. The Commission consults the relevant committee depending on the policy area: food & feed safety, animal health & welfare and plant health. Committee members are national experts who represent EU governments and public authorities.

Standing Committee on Plants, Animals, Food and Feed

The Standing Committee on Plants, Animals, Food and Feed (**PAFF Committee**) plays a key role in ensuring that Union measures on food and feed safety, animal health & welfare as well as plant health are practical and effective. It delivers opinions on draft measures that the Commission intends to adopt. For more information you should visit the Comitology Register.

The PAFF Committee is composed by representatives of all EU countries and presided by a European Commission representative.

The PAFF Committee's mandate covers the entire food supply chain -from animal health issues on the farm to the product on the consumer's table - helping the EU deal effectively with health risks at every stage of the production chain.

Sections of the PAFF Committee

The Standing Committee on Plants, Animals, Food and Feed is divided into 14 different sections, **please see the list on the left hand side menu**. By clicking on the Committee name you will be redirected to a page where you can find agendas and short reports of the different sections.

Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

Provisional planning (last update 28/01/20) Standing committee meetings 2020 for Directorates D – E - G

MONTH			January	February	March	April	May	June	July	August	September	October	November	December
Section	CODE	UNITS												
Standing Committee on Plants, Animals, Food and Feed (PAFF Committee)														
GENERAL FOOD LAW	C20406	E1 E2		7		21		10				5		4
BIOLOGICAL SAFETY OF THE FOOD CHAIN	C20404	G4			23	28	27	23			16	12	10	10
NOVEL FOOD & TOXICOLOGICAL SAFETY OF THE FOOD CHAIN	C20408	E2		21		27		23			21		17	
ANIMAL NUTRITION	C20403	E5		10-11-12		1-2-3		24-25-26			14-15-16		12-13	14-15-16
GENETICALLY MODIFIED FOOD AND FEED	C20409	E3	AC 23		6	22		12	10		15	14	12	7
ANIMAL HEALTH AND WELFARE	C20402	G2 G3 G5 D4 (Joint meetings)	16	13-14	18-19	22-23	14-15	17-18	15-16		23-24	19-20	19-20	14-15
CONTROL AND IMPORT CONDITIONS	C20405	G2 G3 D1 D2 D3 (Joint meetings)												
Phytopharmaceuticals LEGISLATION	C20407	E4			23-24		18-19		16-17			22-23		3-4
Phytopharmaceuticals PESTICIDE RESIDUES	C20401	E4		17-18				15-16			28-29		23-24	

EUROPEAN COMMISSION

Health and Food Safety Directorate General

sante.ddg2.g.5(2020)206985

Standing Committee on Plants, Animals, Food and Feed
Section *Phytopharmaceuticals - Residues*
17 - 18 February 2020

CIRCABC Link: *https://circabc.europa.eu/w/browse/ccb94b1c-8663-4064-aa68-96eb7c9eaf38*

AGENDA

EUROPEAN COMMISSION

Health and Food Safety Directorate General

B.07 Exchange of views and possible opinion of the Committee on a draft Commission Regulation (EU) No …/… amending Annex III to Regulation (EC) No 396/2005 of the European Parliament and of the Council as regards maximum residue levels for chlorate.

(SANTE/10684/2015)

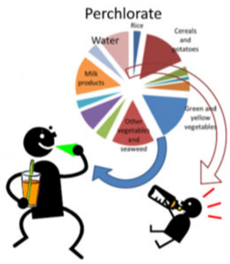
Legal Basis: Regulation (EC) No 396/2005 - Articles 14(1)(a) and 16(1)(a)

Procedure: Regulatory procedure with scrutiny

Standing Committee on Plants, Animals, Food and Feed
Section *Phytopharmaceuticals - Residues*
17 - 18 February 2020

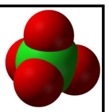
Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

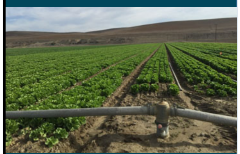
A Public Risk?



Asami et al., 2013, Science of the Total Environment 463–464 (2013) 199–208

Perchlorate





What we know?

1. Perchlorate (ClO_4^-) **occurs naturally in the environment and water**.
2. **Soil and fertilizers are considered to be potential sources** of perchlorate contamination in food.
3. Perchlorate can also be formed during the **degradation of sodium hypochlorite** used to disinfect water
4. EFSA derived a chronic **tolerable daily intake (TDI) of 0.3 µg/kg body weight (bw) per day**.

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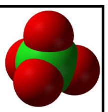
Perchlorate



What we know?

EUROPEAN COMMISSION
HEALTH AND CONSUMERS DIRECTORATE-GENERAL
Safety of the Food Chain
Chemicals, contaminants, pesticides

Annex

Statement as regards the presence of perchlorate in food agreed by the Standing Committee of the Food Chain and Animal Health on 16 July 2013

- The **non-harmonised enforcement approach** as regards the presence of perchlorate in food, in particular fruits and vegetables have caused some tension in the market.
- **The Standing Committee on the Food Chain and Animal Health agreed on 16 July 2013 on the establishment of a common provisional enforcement approach.**

FIRST AGREEMENT IN 2013

Levels of perchlorate as reference for intra-Union trade

* all food / fruits and vegetables	0.5 mg/kg
with the exception of:	
* citrus fruits, pome fruit, root and tuber vegetables, table grapes, spinach, melons and watermelons	0.2 mg/kg
* leaf vegetables (except spinach), fresh herbs and celery – grown in glasshouses/under cover	1.0 mg/kg

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Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

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Perchlorate

What we know?

These **revised levels as reference for intra-Union trade** are of application as **from 16 March 2015**, except for herbal and fruit infusions which was 1 July 2015.

EUROPEAN COMMISSION
Safety of the Food Chain

Statement as regards the presence of perchlorate in food

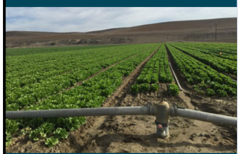
endorsed by the Standing Committee on Plants, Animals, Food and Feed on 10 March 2015, updated on 23 June 2015

SECOND AGREEMENT IN 2015

FOOD (*)	level (mg/kg) (*)
Fruits and vegetables	0,1
with the exception of	
- *Cucurbitaceae* and leafy vegetables except	0,2
- - celery and spinach grown in glasshouse/undercover	0,5
- - herbs, lettuce and salad plants, including rucola, grown in glasshouse/under cover	1,0
Dried spices (except dried herbs and paprika), dried hops	0,5
Tea (*Camellia sinensis*), dried	0,75
Herbal and fruit infusions, dried	0,75
Foods for infants and young children - ready-to-eat	0,02
Other food	0,05

AHDB CSIC Quality, Safety and Bioactivity of plant foods

Perchlorate



L 111/32 EN Official Journal of the European Union 30.4.2015

RECOMMENDATIONS

COMMISSION RECOMMENDATION (EU) 2015/682
of 29 April 2015
on the monitoring of the presence of perchlorate in food
(Text with EEA relevance)

- EFSA recommended that there is a **need for more data on the occurrence of perchlorate in food in Europe**, especially for vegetables, infant formula, milk and dairy products, to further reduce the uncertainty in the risk assessment.
- **Member States should**, with the active involvement of food business operators, **perform monitoring for the presence of perchlorate in fruits, vegetables** and processed products thereof, including juices.

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Contaminants - maximum levels for perchlorate in foods back Tweet

30 October 2019

The EU Member States voted in favour on the Commission´s proposal amending Regulation (EC) 1881/2006 as regards maximum levels of perchlorate in certain foods.

Where are we on chlorate and perchlorate?
Ana Allende, CEBAS-CSIC, Spain

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Perchlorate

EUROPEAN COMMISSION

Brussels, XXX
SANTE/10126/2019
[…](2019) XXX draft

DRAFT

COMMISSION REGULATION (EU) …/…

of XXX

amending Regulation (EC) 1881/2006 as regards maximum levels of perchlorate in certain foods

(Text with EEA relevance)

4 NOVEMBER 2019

Maximum Levels of Perchlorate in Foods – November 2019

The EU commission has voted favourably on the amendment to Regulation 1881/2006 stipulating maximum levels of perchlorate in produce and in certain foods.

In summary, Draft Regulation 10126/2019 adopts maximum level of Perchlorate in fruit and vegetables follows:

Foodstuffs	Maximum level (mg/kg)	
Perchlorate	-	
Fruits and vegetables	0.05	
with the exception of: - Cucurbitaceae and kale	0.10	
with the exception of:- leaf vegetables and herbs	0.50	
Tea (Camellia sinensis), dried Herbal and fruit infusions, dried	0.75	
Infant formula, follow-on formula, foods for special medical purposes intended for infants and young children and young child formula	0.01	
Babyfood	0.02	
Processed cereal based food	0.01	

Where are we on chlorate and perchlorate?

Ana Allende, CEBAS-CSIC, Spain

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FINAL REPORT

An investigation of perchlorate levels in fruit and vegetables consumed in the UK

Final Report to the UK Food Standards Agency covering perchlorate analysis

FS102077

Fera report Reference FD15/10

1/4/2016

Dr Sadat Nawaz, Fera Science Ltd

Food	mg/kg
Fruits and vegetables	0.05
with the exception of	
- Cucurbitaceae, kale	0.1
- Leaf vegetables, herbs and edible flowers	0.5
Tea (Camellia sinensis), dried	0.75
Herbal and fruit infusions, dried	0.75

Reachable?

Description	Perchlorate (mg/kg)	Country of Origin	
Spinach	0.050	United Kingdom	0.5 mg/kg
Kale	0.013	United Kingdom	0.1 mg/kg
Spring Greens	<0.005	United Kingdom	0.5 mg/kg
Broccoli	~0.009	Spain	0.05 mg/kg
True Spinach	<0.005	United Kingdom	0.5 mg/kg
Spinach	<0.005	United Kingdom	
Spreen Green	<0.005	United Kingdom	
Broccoli	~0.006	Spain	0.05 mg/kg
Iceberg Lettuce	<0.005	Spain	0.5 mg/kg
Lettuce	~0.006	United Kingdom	
Gem Lettuce	<0.005	United Kingdom	
Gem Lettuce	~0.007	Spain	
Wild Rocket	0.011	United Kingdom	
Lettuce	<0.005	United Kingdom	
Wild Rocket	0.10	Italy	0.5 mg/kg
Gem Lettuce	<0.005	United Kingdom	
Apollo Lettuce	~0.009	United Kingdom	
Gem Lettuce	<0.005	United Kingdom	
Crispy Salad	0.014	United Kingdom	
Butterhead Lettuce	<0.005	United Kingdom	
Kale	0.013	United Kingdom	

- 40 samples of leafy vegetables and salad were tested
- 11 samples were found to contain perchlorate between **0.011 and 0.18 mg/kg**.

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hortidaily

Food	mg/kg
Fruits and vegetables	0.05
with the exception of	
- Cucurbitaceae, kale	0.1
- Leaf vegetables, herbs and edible flowers	0.5
Tea (Camellia sinensis), dried	0.75
Herbal and fruit infusions, dried	0.75
Infant formula, follow-on formula (3) (4)	0.01
Babyfood (3) (4)	0.02
Processed cereal based food (3) (29)	0.01

Reachable?

Germany: Few problems with perchlorate in fruit and vegetables

The Lower Saxony Bureau for Consumer protection and Food Safety tested 149 fruit and vegetable samples for the presence of perchlorate in June and July. Only two samples of lettuce were found to contain a clearly higher perchlorate level, reports the German website Proplanta.de.

Perchlorates are used industrially as fuel for rockets and fireworks, among other things. They also occur naturally, for instance in sodium nitrate, which is often used in fertilisers. The use of the substance in fertilisers is also the most likely cause of the presence of perchlorate residue in fruit and vegetables.

Strawberries, cherries, lettuce, asparagus, tomatoes and herbs, among other things, were tested for the presence of perchlorate in the food and veterinary institute Oldenburg (LVI). Perchlorate could be found in 43 samples (29%) in total. The highest perchlorate values (4.56 mg/kg and 3.02 mg/kg) were found in two samples of lettuce from conventional cultivation. Only these two samples were over the maximum limit of perchlorate.

149 samples
43 samples showed perchlorates
Highest values in lettuce

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CSIC
Quality, Safety and Bioactivity of plant foods

Ana Allende

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Consejo Superior de Investigaciones Científicas

Chlorate and Perchlorate

Maximum Residue Levels

Update

AHDB
HORTICULTURE
AHDB Strategy 2017–2020
Inspiring Success

Managing contamination risks in fresh produce production: webinar

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Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.

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Microbials ' Keep it Clean Conference

Chlorate & perchlorate risks and mitigation

Mabel Gil, CEBAS-CSIC,
CEBAS-CSIC, Murcia, Spain

CSIC

Quality, Safety and Bioactivity of plant foods

18 February 2020

OBJECTIVE

How to mitigate against chlorate and perchlorate exceedances in fruit and vegetables when using chlorine compounds for disinfecting water

IRRIGATION water and PROCESS water


Chlorate risk

The presence of chlorate in fresh produce has been linked to the use of **CHLORINATED WATER:**

- For **IRRIGATION** and the chemical accumulation during crop production
- For **PRODUCE WASHING** and **DISINFECTION OF PROCESSING EQUIPMENT**


Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.

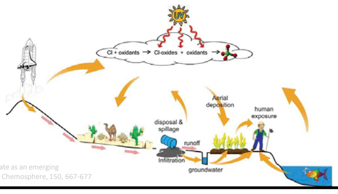
Perchlorate risk

The presence of perchlorate in fresh produce has been linked to:

- **NATURAL PRESENCE** in the environment from nitrate and potash and accumulation of in the soil and groundwater

-**ENVIRONMENTAL CONTAMINANT** from the use of certain fertilizers and industrial processes

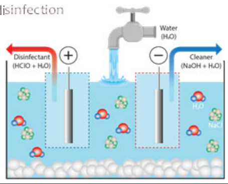
- **WATER DISINFECTION** with chlorinated substances



Kumarathilaka et al., 2016. Perchlorate as an emerging contaminant in soil, water and food. Chemosphere, 150, 667-677

Disinfection Technologies

- **Chlorine derivative solutions:**
  - Sodium hypochlorite — Na ClO + H2O ⟶ NaOH + HOCl
  - Calcium hypochlorite — Ca(ClO)2 + H2O ⟶ Ca (OH)2 + 2HOCl
  - Chlorine gas — Cl2 + H2O ⟶ HCl + HOCl
  - Electrochemical disinfection



Disinfection by-products (DBPs)

Chlorine derivative solutions can lead to the presence of DBPs

- Organic DBPs generated from the oxidation of organic matter:
  - Trihalomethanes (THMs)
  - Haloacetic acids (HAAs)

- **Inorganic DBPs formed during the manufacture and storage:**
  - **Chlorate**

OCl^- (hypochlorite) + OCl^- (hypochlorite) ⟷ ClO_2^- (chlorite) + Cl^- (chloride)
ClO_2^- (chlorite) + OCl^- (hypochlorite) ⟷ ClO_3^- (chlorate) + Cl^- (chloride)
ClO_3^- (chlorate) + OCl^- (hypochlorite) ⟷ ClO_4^- (perchlorate) + Cl^- (chloride)

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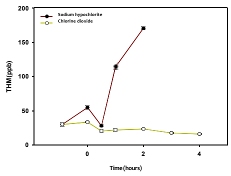
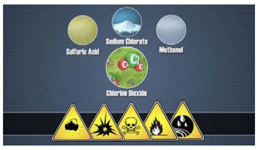
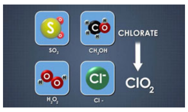
Disinfection Technologies

- Chlorine dioxide: DBPs







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Disinfection of irrigation water

It is recommended to reduce microbiological contamination and ensure the food production compliance with established microbial limits, particularly faecal indicator bacteria such as *Escherichia coli*.

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Disinfection of irrigation water

Presence of chlorate in the crop

1. Sprinkler irrigation in greenhouse: Electrolysed water (Red baby lettuce)

2. Drip irrigation in open field: Sodium hypochlorite (Romaine lettuce)

Disinfection of irrigation water

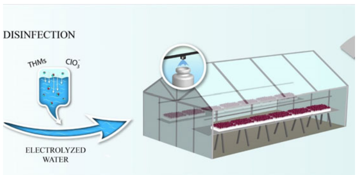
1. Electrolysed water (EW)

The use of EW for the disinfection of irrigation water could cause the presence of chlorate in the water and in the crop, and postharvest practices could also have an impact on their accumulation.

Disinfection of irrigation water

1. Electrolysed water (EW)

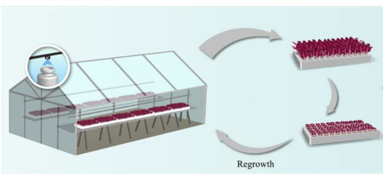
The water used for irrigation was surface water from a reservoir mixed with the concentrated EW at ~5 mg/L free chlorine.



The irrigation water treated with EW pumped into the greenhouse and applied by sprinkler irrigation for Red Oak Leaf and Red Batavia cultivation

Disinfection of irrigation water

1. Electrolysed water (EW)



Baby lettuce was harvested from the same trays corresponding to the 1^{st}, 2^{nd} and 3th harvests.

Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.

CSIC Quality, Safety and Bioactivity of plant foods

Disinfection of irrigation water

AHDB

1. Electrolysed water (EW)

After harvest, baby lettuce was washed, rinsed, centrifuged, packaged in passive MAP and stored in darkness at 7 ºC.

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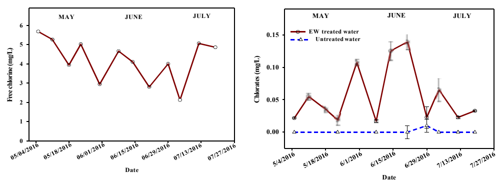
Disinfection of irrigation water

AHDB

1. Electrolysed water (EW)

Free chlorine in EW and chlorates in EW treated and untreated water



EW treated water significantly increased the amount of chlorates although the levels were below those permitted in potable water (0.7 mg/ L).

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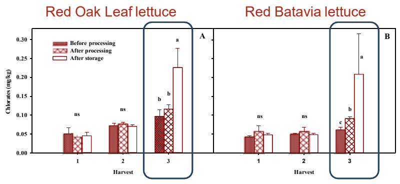
Disinfection of irrigation water

AHDB

1. Electrolysed water (EW)

Content of chlorates before and after processing and storage
Irrigation water (0.02–0.14 mg/L), and in the fresh produce (0.05–0.10 mg/kg)



Differences in chlorate content of baby lettuce after harvest and after storage could be due to differences in extracting the sample.

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METHOD V 10

Improvements in chlorate analysis

A method is described for the residue analysis of very polar pesticides such as chlorate in foods of plant origin including fruits and vegetables.

European Commission EURL-SRM EU Reference Laboratories for Residues of Pesticides Single Residue Methods

Quick Method for the Analysis of Numerous Highly Polar Pesticides in Foods of Plant Origin via LC-MS/MS Involving Simultaneous Extraction with Methanol (QuPPe-Method)

I. Food of Plant Origin (QuPPe-PO-Method)

Version 10 (09.01.2019, Document History, see page **73**)

Authors: M. Anastassiades; D. I. Kolberg; E. Eichhorn; A. Benkenstein; A.-K. Wachtler; S. Zechmann; D. Mack; C. Wildgrube; A. Barth; I. Sigalov; S. Görlich; D. Dörk; G. Cerchia

EU Reference Laboratory for pesticides requiring Single Residue Methods (EURL-SRM)
Address: CVUA Stuttgart, Schaflandstr. 3/2, DE-70736 Fellbach, Germany

CSIC Quality, Safety and Bioactivity of plant foods

AHDB

METHOD V 10

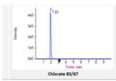
1. Sample preparation

To improve the homogeneity: samples are preferably milled cryogenically to reduce analyte degradation and particle sizes, and residue accessibility.

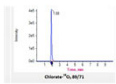
2. Chlorate analysis

Quantification is performed using a isotopically labeled analogue of the target analyte as internal standard (**ILIS**).

Chlorate $^{16}O_3$ 83/67



Chlorate $^{18}O_3$ 89/71



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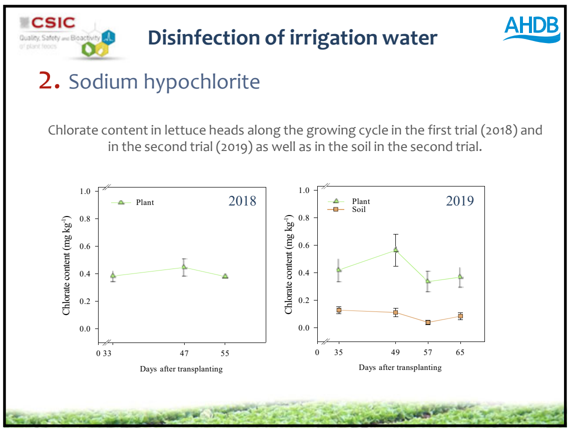
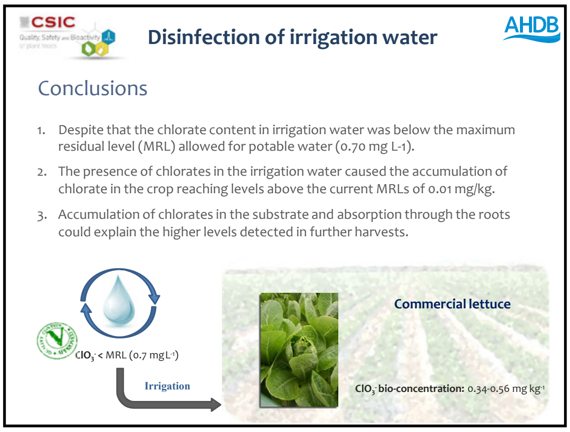
Disinfection of irrigation water

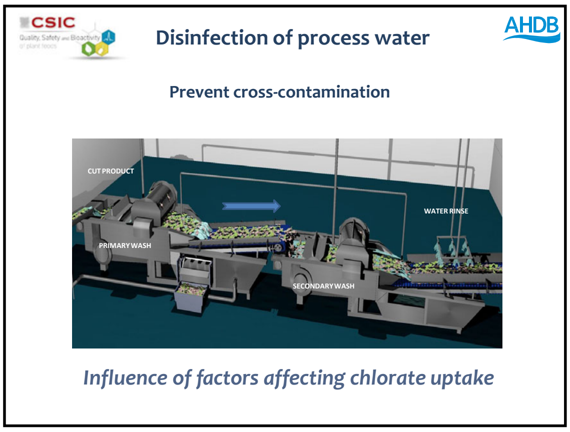
2. Sodium hypochlorite

Lettuce heads cultivated in commercial open field irrigated with reclaimed water from a Municipal Wastewater Treatment Plant (MWTP)

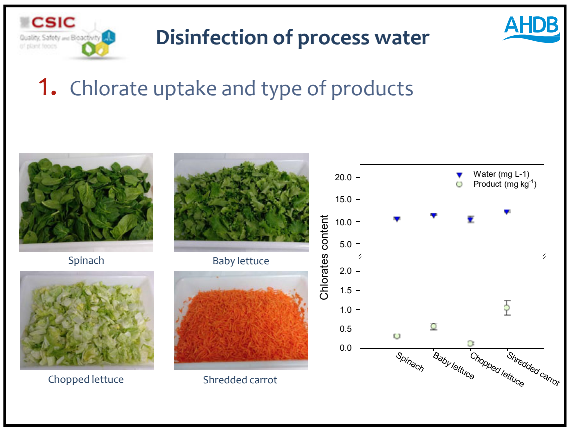
Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.

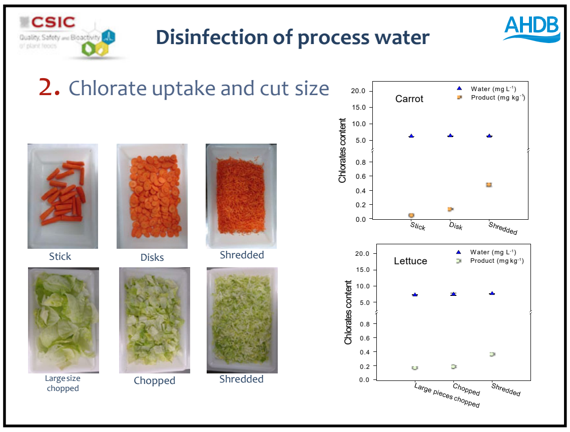


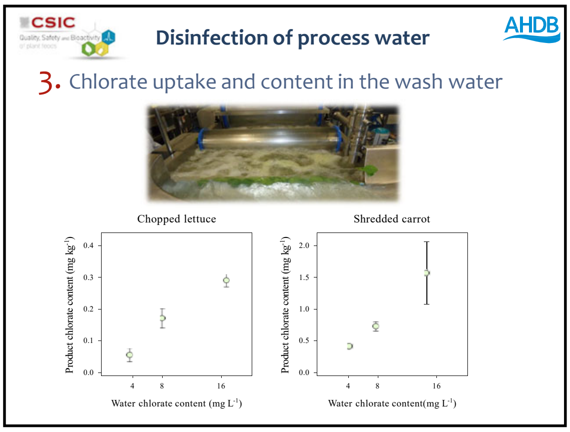




Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.



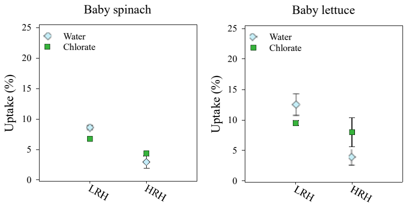




Disinfection of process water

CSIC | AHDB

4. Chlorate uptake and produce hydration



Disinfection of process water

CSIC | AHDB

5. Chlorate uptake and washing time

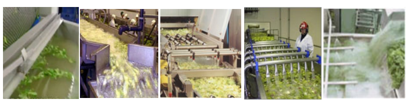
Chlorate uptake is greater when the products are washed for longer periods (2 min versus 1 min), but significant differences can be observed depending on the product.

Disinfection of process water

CSIC | AHDB

Conclusions

1. The contributing factors for the uptake of chlorate during washing by different products is mainly affected by the cut piece size.
2. When the size of the cut pieces decreased, the content of chlorate uptake increased.
3. The accumulation of chlorate showed a linear response with the chlorate present in the wash water.
4. Lower hydration status and longer washing times increased chlorate uptake.



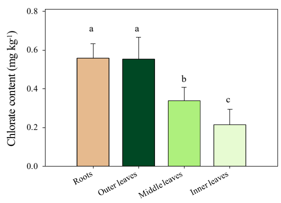
Mitigation strategies

To prevent chlorate accumulation in fresh produce when using disinfection technologies for **IRRIGATION WATER**

Mitigation strategies

1. Elimination of external leaves

The chlorate content gradually decreased from the outer leaves to the inner leaves and the root was the part of the lettuce head with the highest accumulation



Mitigation strategies

2. Alternative treatments

Alternative disinfection treatment to chlorine for the irrigation of edible crops as the **ULTRAVIOLET TREATMENT or OZONE**

Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.

CSIC AHDB

Mitigation strategies

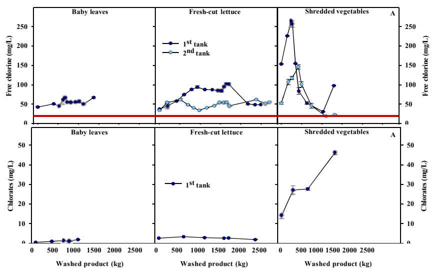
To prevent chlorate accumulation in fresh produce when using disinfection technologies for **PROCESS WATER**

CSIC AHDB

Mitigation strategies

1. Optimal doses

Commercial processing lines



Poor control of free chlorine

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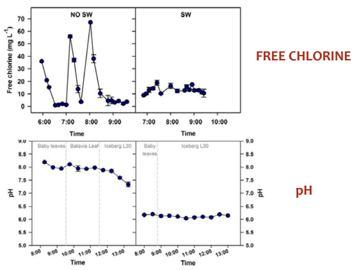
Mitigation strategies

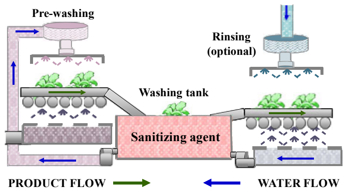
2. A better monitoring and control system

Without control Monitoring and Control System



Mitigation strategies

3. Pre-wash

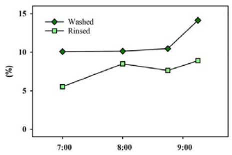


Fresh-cut product sanitation and wash water disinfection: Problems and solutions (Gil et al., 2009)

Mitigation strategies

4. Optimal rinse

Chlorates in the washed and rinsed produce



Water rinse reduces the uptake of chlorates

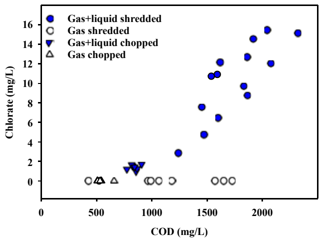
Mitigation strategies

5. Water refreshment

Mitigation strategies

6. Selection of the chlorine source

Chlorate in the process water: chlorine gas with or not with liquid chlorine

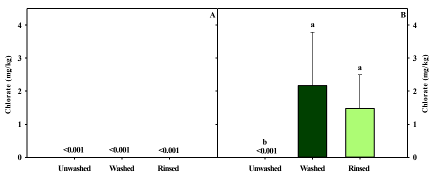


Mitigation strategies

6. Selection of the chlorine source

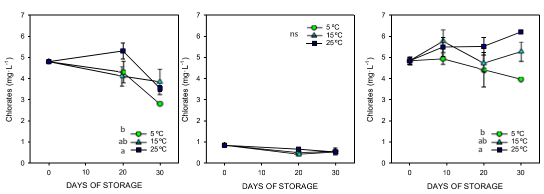
Chlorate in unwashed, washed, and rinsed shredded lettuce

Chlorine gas | Chlorine gas + liquid chlorine



Disinfection of process water

7. Storage conditions



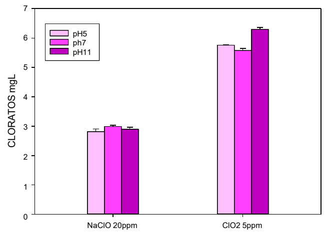
20 mg·L^{-1} of free chlorine

5 mg·L^{-1} of ClO$_2$

Chlorate & perchlorate risks and mitigation
Mabel Gil, CEBAS-CSIC.

Disinfection of process water

7. Storage conditions

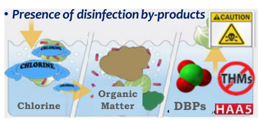


Disinfection of process water

Conclusions

The purpose is to prevent cross-contamination and the uptake of chlorate by the product. Thus, we need to integrate all the factors:

1. Optimal dose,
2. Better monitoring and control,
3. Pre-wash and rinse,
4. Refreshment and
5. Fresh and diluted solutions.



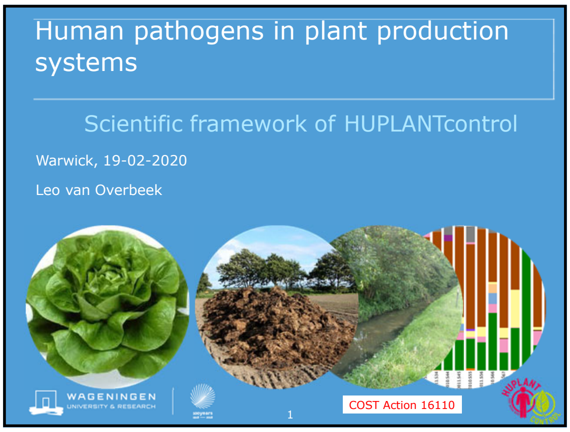
Chlorate & perchlorate risks and mitigation

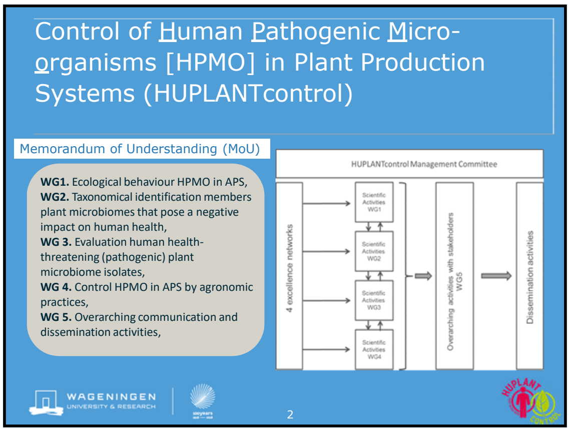
Thank you for your attention

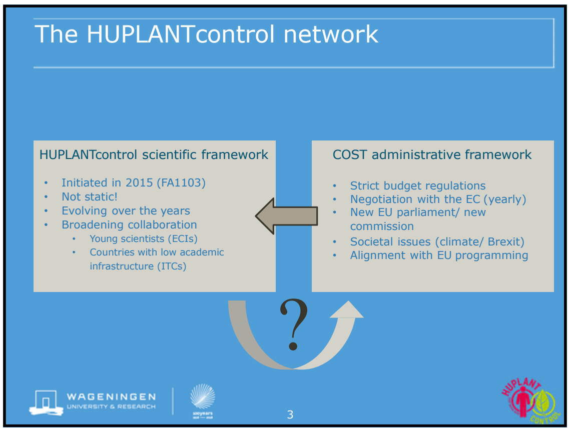
Mabel Gil, CEBAS-CSIC,
migil@cebas.csic.es

'HUPLANTcontrol' – is there anything in it for growers?

Leo van Overbeek, Wageningen University, The Netherlands







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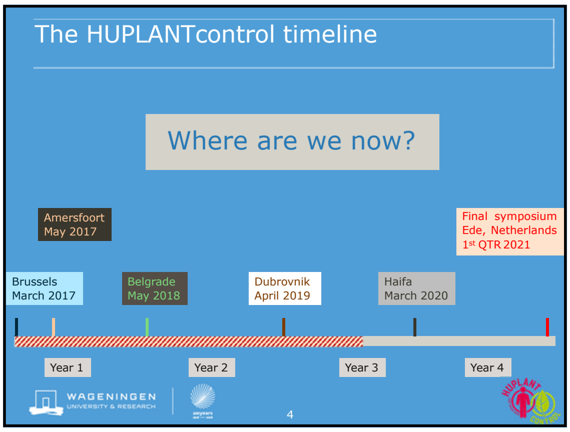

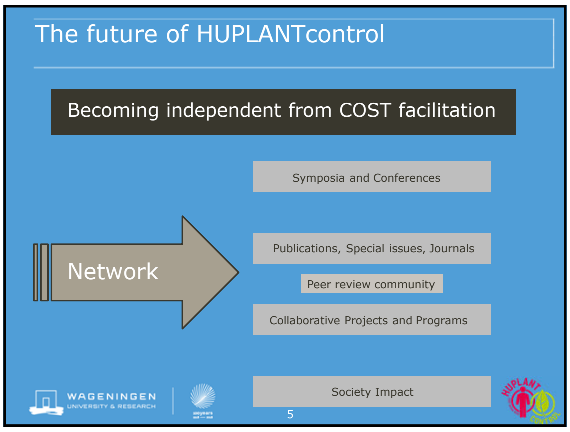

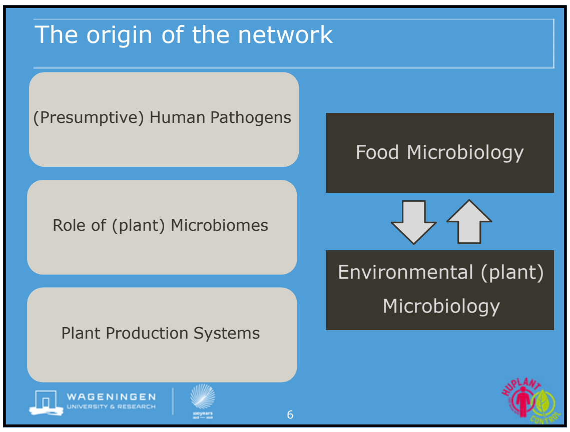

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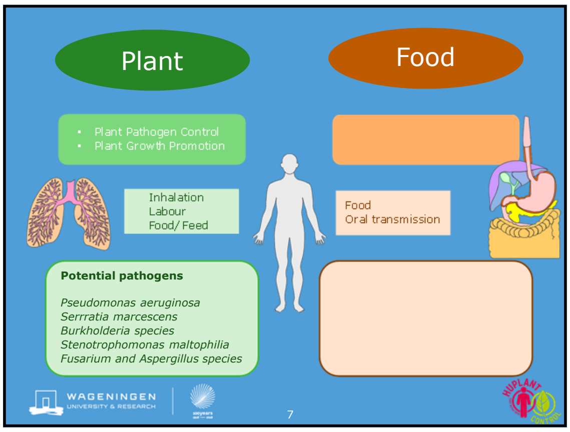

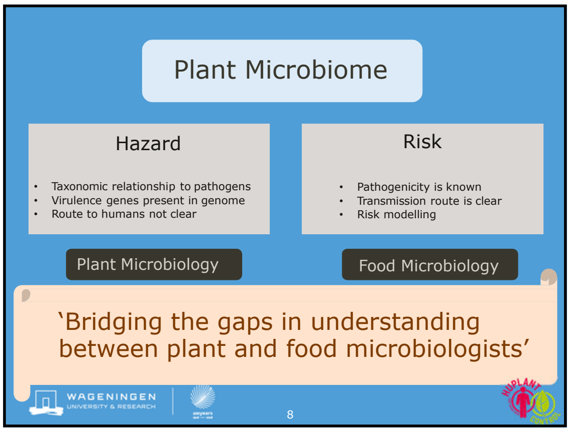

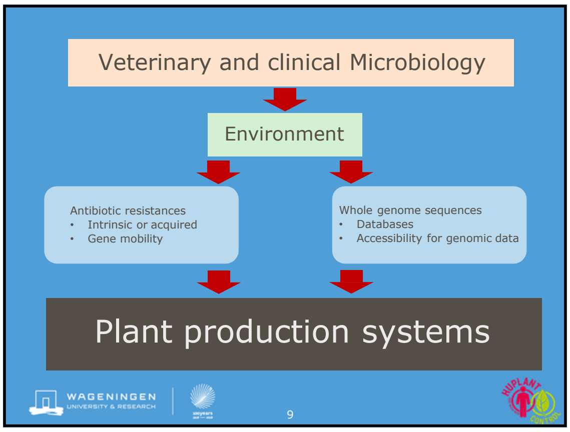

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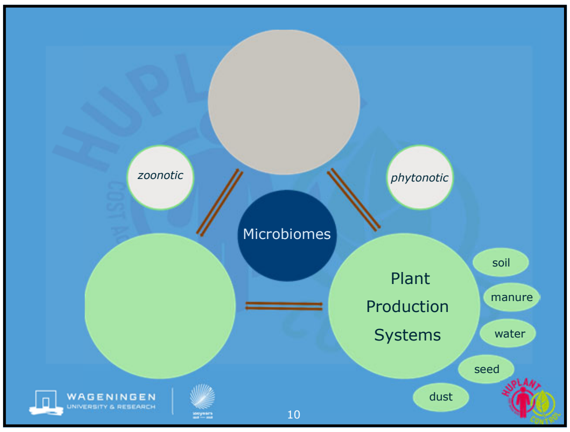

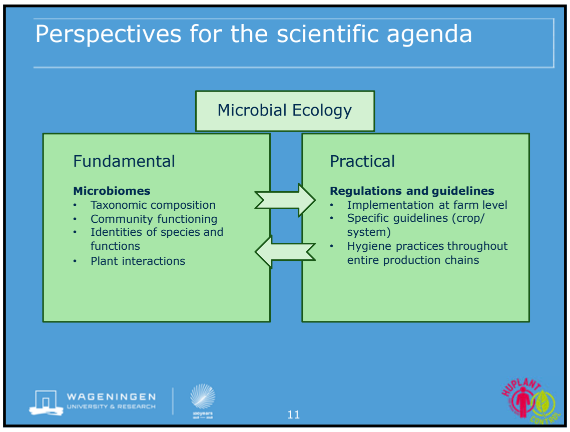

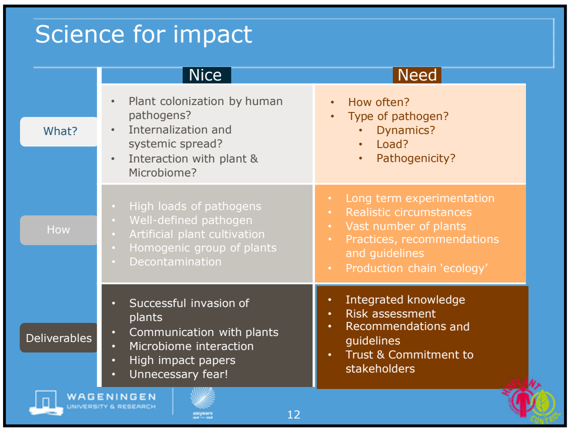

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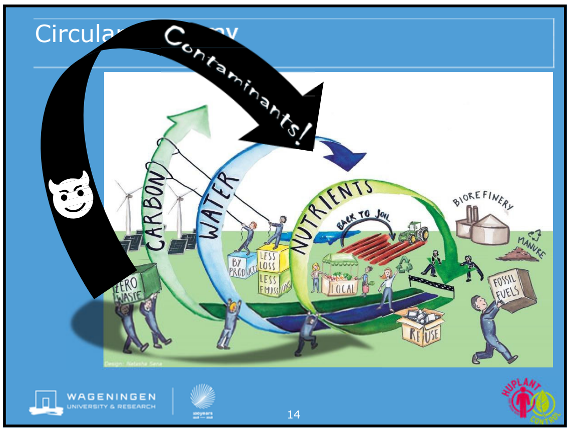

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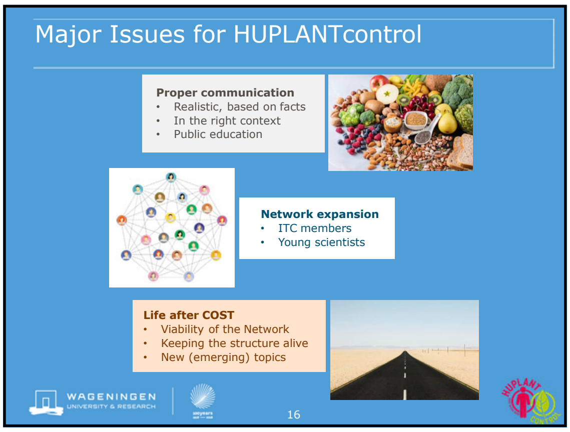
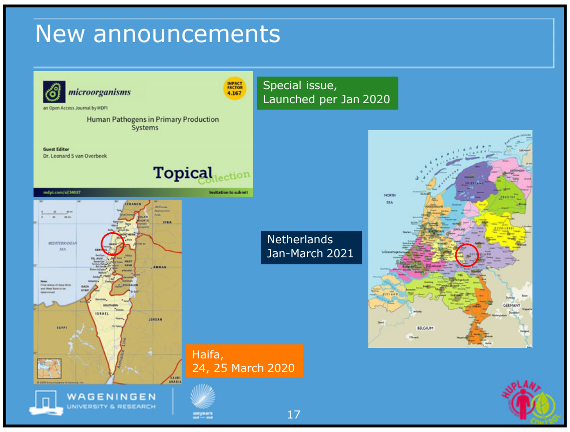




Main microbes of concern as defined by the EU Commission good hygiene guidance document on microbiological risks in FFV at primary production

Mike Hutchison

www.hutchisonscientific.com
Microbiological Food Safety Research and Consultancy

23.5.2017 EN Official Journal of the European Union C 163/1

IV

(Notices)

NOTICES FROM EUROPEAN UNION INSTITUTIONS, BODIES, OFFICES AND AGENCIES

Commission notice on guidance document on addressing microbiological risks in fresh fruits and vegetables at primary production through good hygiene

(2017/C 163/01)

CONTENTS

(1) VTEC in seeds and sprouted seeds ([3])

(2) *Salmonella* and *Norovirus* in food of leafy greens eaten raw as salads.

(3) *Salmonella* and *Norovirus* in berries.

(4) *Salmonella* and *Norovirus* in tomatoes.

(5) *Salmonella* in melons.

(6) *Salmonella*, *Yersinia*, *Shigella* and *Norovirus* in bulb and stem vegetables, and carrots.

Salmonella

- Bacteria – wide host range
- Over 2000 different types (serovars)
- Enteric human pathogen
- Routinely carried in livestock – chickens, pigs, cattle
- And wildlife – foxes, birds, deer
- Mostly without symptoms, so a zoonotic agent
- Contamination source likely to be faecal material
- Humans: From no symptoms to cramp, diarrhoea, fever <72h; infection duration: a couple of days.
- Classic routes:

dogs and bones, cats and birds, animal defaecation, overland flow, flooding, application of contaminated water

Noroviruses

- Numerous name changes in last decade – Norwalk OH
- Winter vomiting bug – cruise ships, hospitals
- RNA virus – very narrow host range
- Can't infect animals so the source is human
- Infected workers
- Sewage that includes waste from someone that was infected
- Preferentially infects blood types A and O
- Infection duration: 72h to several weeks (w/ shedding)
- Classic sources: Septic tanks, release of untreated waste by water companies
- Viruses are hard to test for in a lab (=tricky, specialist and expensive). ELISA or RT-PCR

Yersinia

- Bacteria – wide host range
- *Yersinia pestis* causes plague – highly unlikely!
- Much more likely *Y. enterocolitica* possibly
  Y. pseudotuberculosis
- Zoonotic agent – main source is pigs (tonsils); also rodents, rabbits, cattle, dogs, cats
- *Y. pseudotuberculosis* grated raw carrots – EU and USA
- Finland: infected shrews picked up with carrots then washed
- Fever, abdominal cramps and diarrhoea (may be bloody)
- Infection duration: 2-3 weeks
- Kids more susceptible to infection than adults
- Increased infections in the winter

Shigella

- Bacteria – only causes disease in primates
- Enteric human pathogen, gut inhabitant, significant amounts of DNA identical with *Salmonella*
- Some strains produce shiga toxin – similar to the toxin secreted by *E. coli* O157
- Abdominal cramps, nausea, vomiting and diarrhoea
- Main transmission is from people to people – faecal/oral route
- Infection duration: up to 1 week
- Kids more susceptible to infection than adults
- Unusual choice for inclusion
- Less than 1/3 of *Shigella* infections are attributable to food
- Most cases: elderly nursing homes, kids nurseries, places with opportunity for poor faecal hygiene

Why the EU picked what they did….

Salmonella and Norovirus in berries
Berries get an unjustified bad press because so many are frozen

Produce	Source	Outbreak	Agent	Reference
Blueberries	USA	USA	*Salmonella* Newport	(Miller et al. 2013)
Berries-Frozen Raspberries	Imported	France	Norovirus	(Cotterelle et al. 2005)
Berries-Frozen Raspberries	Poland	Denmark	Norovirus	(Falkenhorst et al. 2005)
Berries - Frozen Raspberries	Unknown	Denmark	Norovirus	(Korsager et al. 2005)
Berries-Raspberries	China	Sweden	Norovirus	(Hjertqvist et al. 2006)

Tomatoes

Salmonella and Norovirus in tomatoes

Produce	Source	Outbreak	Agent	Reference
Tomato	USA	USA	*Salmonella* Montevideo	(Anon 2001)
Tomato	USA	USA	*Salmonella* Javiana	(Anon 2001)
Tomato	USA	USA	*Salmonella* Basildon	(Anon 2001)
Tomato	Various	International	Norovirus	(Serracca 2012 review)
Couldn't find much evidence for Norovirus in fresh tomatoes only processed/dried				
Tomato	Unknown	N. America	*Salmonella* Braenderup	(CDC 2005a)
Tomato	Unknown	N. America	*Salmonella* Braenderup	(CDC, 2007a)
Tomato	USA	USA	*Salmonella* Newport	(Greene et al 2008)
Tomato	Unknown	USA	*Salmonella* Braenderup	(Gupta et al. 2007)
Tomato	USA	USA	*Salmonella* Basildon	(Reller et al. 2006)

Carrots

But carrots are right on the money

Produce	Source	Outbreak	Agent	Reference
Carrots	USA	USA	*Enterotoxigenic Escherichia coli*	(Anon 2001)
Carrots	Unknown	UK	*Norovirus*	(Anon 2005)
Carrots	Unknown	USA	*Salmonella* Braenderup	(CDC 1990)
Carrots	USA	USA	*Salmonella* Typhimurium	(CDC 2005)
Carrots	USA	USA	*Salmonella* spp.	(Erickson 2010)
Carrots	Unknown	USA Japan Samoa	*Shigella sonnei*	(Gaynor et al. 2009)
Carrots	Finland	Finland	*Yersinia pseudotuberculosis*	(Jalava et al. 2006)
Carrots	Finland	Finland	*Yersinia pseudotuberculosis*	(Rimhanen-Finne et al. 2009)

- Lots of information describing fate on potential human pathogens in soil and manures.
- Not very much about post-harvest storage

Food Standards-funded research

The fate of verocytotoxic *E. coli* contaminating the rhizospheres of root vegetables moving through the processing and retail distribution chains

Study commissioned:

- **Mainly in response to 2010/11 leek/potato-associated outbreak of VTEC in the UK**
- **Determine plausibility of contaminated crops persisting through processing and distribution and reaching domestic/retail environments**

Main study aims:
Most likely contamination routes

Pre-harvest

1. The deposition of **naturally-contaminated manure** onto crops close to harvest
2. The application of **contaminated irrigation water** onto root crops close to harvest. This scenario would also provide information on crop contact with contaminated runoff during a heavy rainfall or flood event.
3. Contaminated water application the night before harvest, which is common for some crops during periods of low rainfall (because crops such as baby carrots can be damaged by **capped soil** [a crust of dry surface soil]).

Post-harvest

4. The use of **uncontaminated water** for **contaminated vegetable** washing and polishing
5. The impact of previously washing a **contaminated batch** of crops on an **uncontaminated batch** of crops without changing the wash water

The study used:

- Potatoes harvested early September
- Leeks harvested November
- Carrots harvested January

Commercial consultation to ensure mimic of growing, harvest period and post-harvest processing practices

Naturally-contaminated manure

- Testing calves presenting for slaughter at BU vet school Langford – 36 farms positive for *stx*
- Dairy cattle slurry – commercial herd
- Grew on UGent chromogenic selective media
- Initially strange serotype
- Wouldn't agglutinate with any antibodies
- Sequencing determined O145, which had a pedigree
- By PCR:

  no H antigen, no *hylA*, no *eae*, no *stx1* or *stx2*
- The slurry was initially contaminated at around 10^4 cfu/g

O145 US outbreak 2010. 27 infected, no deaths Traced to romaine lettuces

Journal of Clinical Microbiology, Mar. 2004, p. 954–962 Vol. 42, No. 3
0095-1137/04/$08.00+0 DOI: 10.1128/JCM.42.3.954–962.2004

Phenotypic and Genotypic Analyses of Enterohemorrhagic *Escherichia coli* O145 Strains from Patients in Germany

Anne-Katharina Sonntag,[1] Rita Prager,[2] Martina Bielaszewska,[1] Wenlan Zhang,[1] Angelika Fruth,[2] Helmut Tschäpe,[2] and Helge Karch[1*]

Institute for Hygiene and National Consulting Laboratory on Hemolytic Uremic Syndrome, University Hospital Münster, 48149 Münster,[1] and National Reference Centre for Salmonella and Other Enteric Pathogens, Robert Koch Institute, Branch Wernigerode, 38855 Wernigerode,[2] Germany

Received 13 August 2003/Returned for modification 23 September 2003/Accepted 4 December 2003

At least half dozen European outbreaks, some with deaths

Potatoes/Leeks we had three treatments:

- 7d prior to harvest
- No contamination – borehole water (tested)
- Contaminated irrigation water (10% slurry)
- Raw cattle slurry

- Three plots for each treatment
- Five samples tested each time (n=15)

Carrots there were four treatments

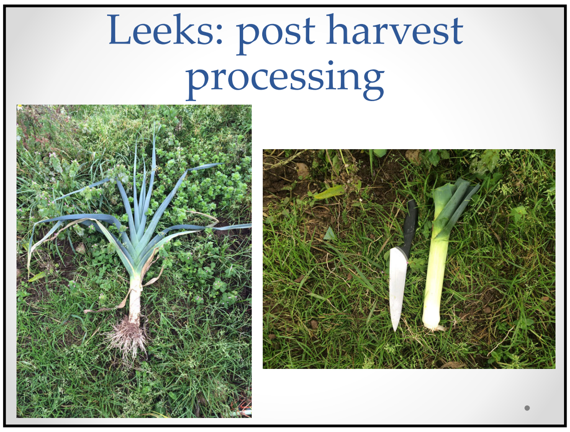
- 7d prior to harvest
- No contamination – borehole water (tested)
- Contaminated irrigation water (10% slurry)
- Raw cattle slurry

- Night before harvest
- Application of contaminated irrigation water (10% slurry)

- Three plots for each treatment
- Five samples tested each time (n=15)

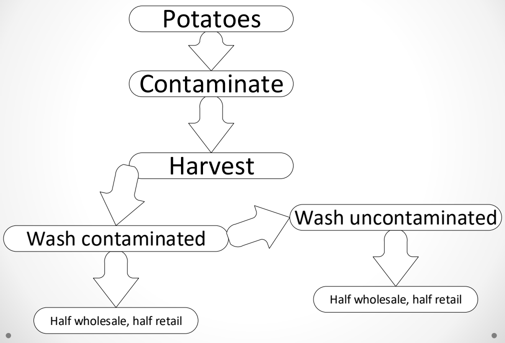
Unusually high rainfall previous two months

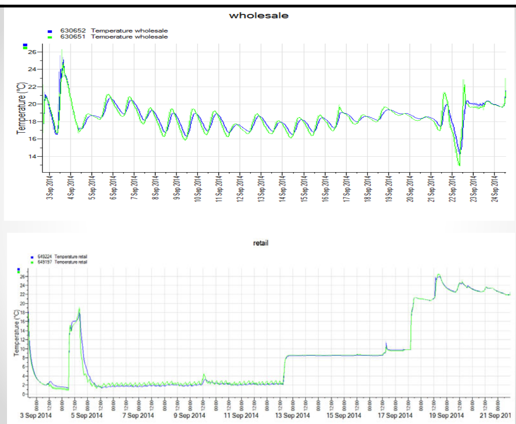
Harvest and washing….


Leeks: post harvest processing

Carrots – post harvest

The 'standard' treatment:





Washing treatments:

- Potatoes – flotation/flocculation tank
- Leeks – spray/misting
- Carrots are different, because abrasive wash treatment – polish and rinse

Carrot washer/polisher

The results:

Crop washing and storage

Potatoes summary:

- At harvest 2 logs contamination for manure, 0.33 logs for irrigation water
- Washing next day caused no significant reduction for the manure
- P=0.5 for the irrigation water on washing – significant reduction (just)
- There was transfer of cells to uncontaminated potatoes if washing was in water previously used to wash contaminated potatoes
- Small quantity of the manure contamination on potatoes persisted until the end of retail distribution, but not wholesale

Leeks summary:

- Washing removed much of the contamination
- However still very small concentrations at end of storage for *all* contaminated treatments
- Typically, 2 or 3 of the 15 tested post store samples contained countable numbers of cells
- Suspect that washing is efficient because leek surfaces are waxy and hydrophobic – they bead water
- Possible rehydration of dried slurry
- Very low numbers in the wash water
- Transfer to uncontaminated crops washed in water used to wash contaminated crops

Leeks

- Damage to vascular tissues
- Release of nutrient from phloem
- Generally, crops with damage to vascular bundle can support growth
- Noted the leeks were all cut, and survival for all contaminated crops to the end of both retail and wholesale simulated distribution
- No evidence of growth, however

Carrots

- High rainfall meant that contamination of the crop at harvest was lower than expected.
- After washing and polishing, *E. coli* O145 was detected only in:
  - one of the fifteen manure treatment replicates
  - five of fifteen water treatments, when the water was applied 24h before harvest as a simulation of flooding (or a soil cap softening treatment)
- No counts (or enrichment isolations) after simulated distribution

Summary of crop washing/distributions

- Survival for potatoes post retail distribution
- Survival for leeks both distributions
  - And for the uncontaminated crops washed in water recycled from the contaminated crop washes
- No survival for carrots after wash/peel both distributions
- PHE theory of contaminated soil on FFV surface was plausible

Since that work was undertaken, things have moved on …

Factors affecting pathogen survival - field

- Most important factor in controlling bacterial numbers on the phylloplane is the UV light in sunshine
- UV damages bacterial DNA
- Bacteria form protective mixed-species biofilms on leaves and stems
- 30%-80% of the total bacterial population on a plant's surface will be in form of a biofilm
- *E. coli* O157:H7 inoculated onto leafy greens could be isolated from lettuce for:
  - More than two weeks after inoculation (lettuce) in field in sunny weather
  - Nearly six months (parsley and lettuce) in a glass house
- Survival is longer on shaded parts of plant compared with leaf upper surfaces

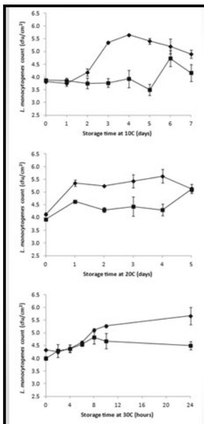
Intact fruit and vegetable surfaces during postharvest handling

- Pathogens list x produce list
- *Listeria monocytogenes* is a fairly hardy bacteria
- Considered to be something of a 'worst case'
- Comprehensive review, January 2020
  https://doi.org/10.4315/0362-028X.JFP-19-283

Microbiological organisms of most concern
Mike Hutchison, Hutchison Scientific

Overview of intact produce

- Produce surface and storage conditions affects survival and growth
- *L. monocytogenes* growth on intact (not damaged) produce can occur
- Different produce can carry different quantities of bacteria
- Little characterisation of produce surface binding capacities
    - Produce cultivar differences
    - Bacterial species differences
    - Bacterial strain differences



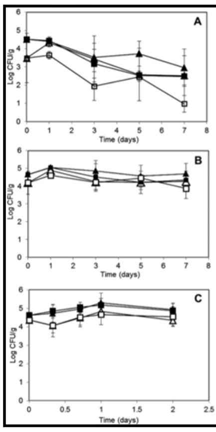
Cucumbers held at ≥20°C

had the highest growth rates

Increases of 0.5-2 log cfu/cm²

53% RH squares, 90% RH diamonds

Source: doi: 10.1111/jfs.12087



E. coli O157 on cut (solid) and uncut (hollow) celery held at 4°C (A), 12°C (B) and 22°C (C) in containers (triangle) or bags (squares)

No growth or slight decrease

Source: https://doi.org/10.1016/j.fm.2012.11.016

In general, mixed bag currently

- Evidence low temperatures
  - Both reduce and preserve pathogen numbers, might be linked to humidity
  - Inhibit pathogen growth generally
- Higher humidity
  - Increases growth generally
- Lower humidity
  - Promotes reductions to some pathogen populations at refrigeration temperatures
- Requirement for better information for fate during storage
  - Produce cultivar differences
  - Bacterial species differences
  - Bacterial strain differences
- We need data to fill in the gaps so modelling can be undertaken

The project team

Harper Adams

- Jim Monaghan and Jenny Heath

Bristol University

- Dawn Harrison, Monika Tchorzewska

HSL

- Charlotte Watkins

Funded by the Food Standards as project FS101059

Practices to help keep fresh produce safe to eat
Ana Allende, CEBAS-CSIC, Spain

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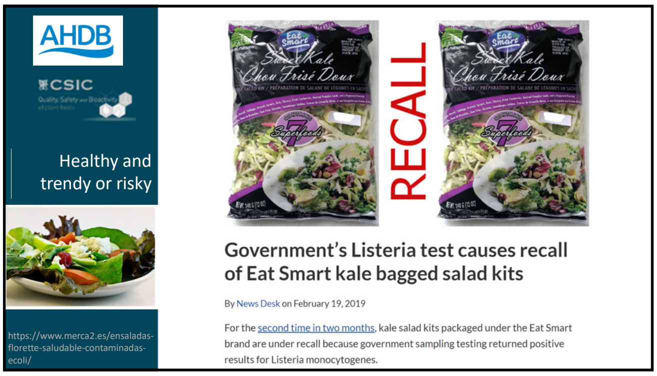

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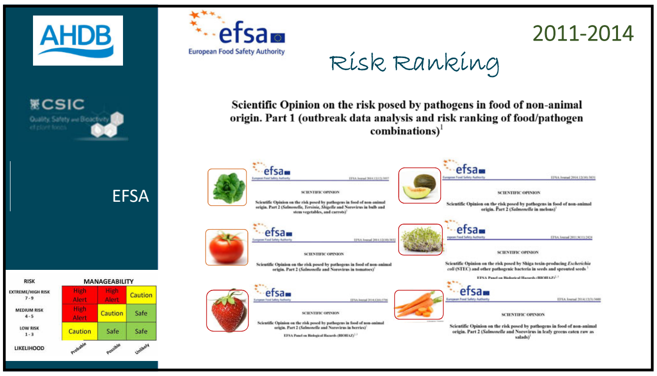

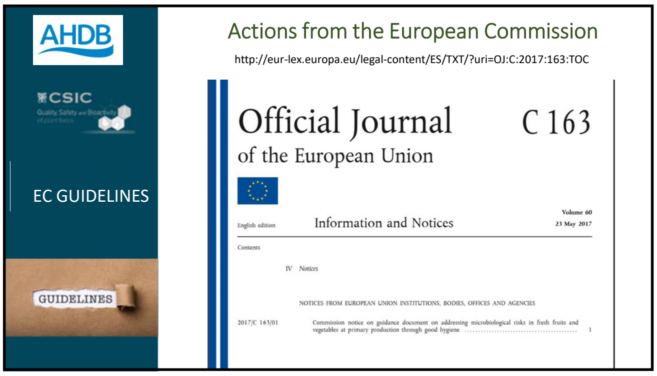

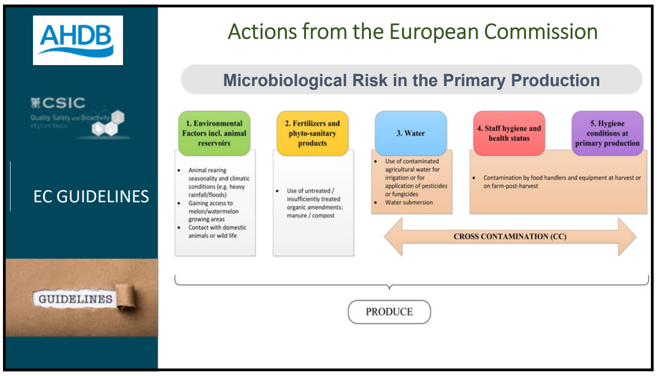

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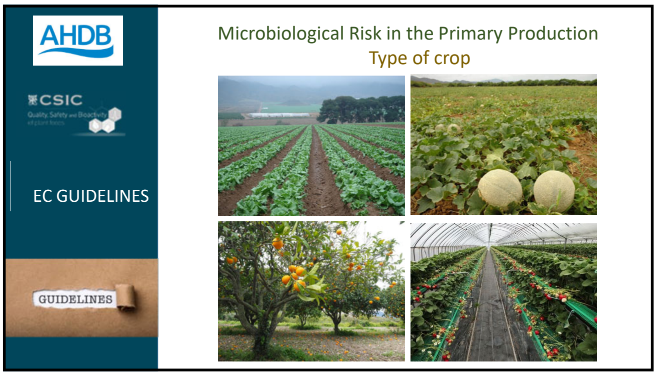

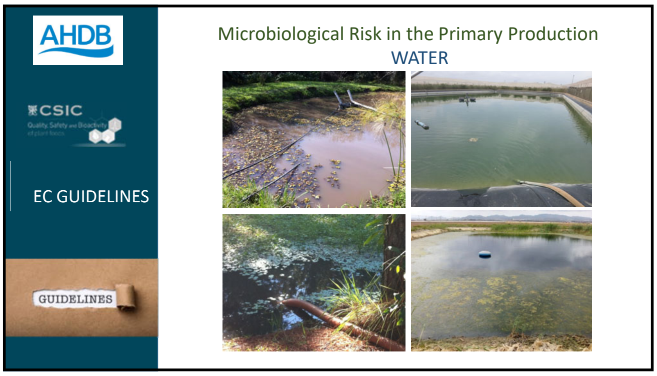

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CSIC Quality, Safety and Bioactivity of plant foods

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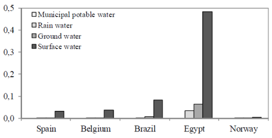
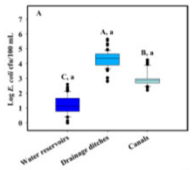
Microbiological Risk in the Primary Production
Research evidences





Ceuppens, S., Johannessen, G.S., Allende, A., Tondo, E.C., El-Tahan, F., Sampers, I., Jacxsens, L., Uyttendaele, M. 2015. Risk Factors for Salmonella, Shiga Toxin-Producing Escherichia coli and Campylobacter Occurrence in Primary Production of Leafy Greens and Strawberries. Int. J. Environ. Res. Public Health 2015, 12, 9809-9831.

Truchado, P., Hernandez, N., Gil, M.I., Ivanek, R., Allende, A. 2018. Correlation between E. coli levels and the presence of foodborne pathogens in surface irrigation water: Establishment of a sampling program. Water Research, 128 226-233.

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Microbiological Risk in the Primary Production
Water

Intended use of the water	Source of water (*)						Indicator of faecal contamination E. coli (*)
	Untreated surface water/open water channels (*)	Untreated ground water collected from wells (*)	Untreated Rain water	Treated (*) sewage/ surface/waste water/water reuse	Disinfected water (*)	Municipal water	
PRE-HARVEST and HARVEST							
Irrigation of FFVs likely to be eaten uncooked (i.e. ready-to-eat FFV) (irrigation water comes into direct contact with the edible portion of the FFV) Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment for ready-to-eat FFV and direct contact.	x	x	▲	•	•	√	100 CFU/100 ml
Irrigation of FFVs likely to be eaten uncooked (i.e. ready-to-eat FFV) (irrigation water does not come into direct contact with the edible portion of the FFV) Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment for ready-to-eat FFV and no direct contact	x	x	▲	•	•	√	1 000 CFU/100 ml (*)
Irrigation of FFVs likely to be eaten cooked (irrigation water comes into direct contact with the edible portion of the FFV). Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment used in this FFV direct contact).	▲	▲	•	•	•	√	1 000 CFU/100 ml
Irrigation of FFVs likely to be eaten cooked (irrigation water does not come into direct contact with the edible portion of the FFV). Dilution or application of pesticide, fertiliser or agrochemicals and cleaning equipment used in this FFV (no direct contact)	•	•	√	√	√	√	10 000 CFU/100 ml

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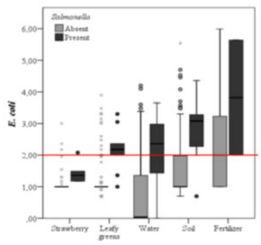
Microbiological Risk in the Primary Production
Scientific evidences



Ceuppens et al. / Int. J. Environ. Res. Public Health 2015, 12, 9809-9831.

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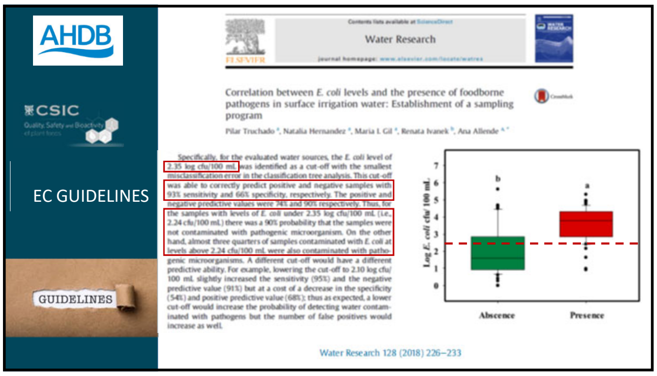

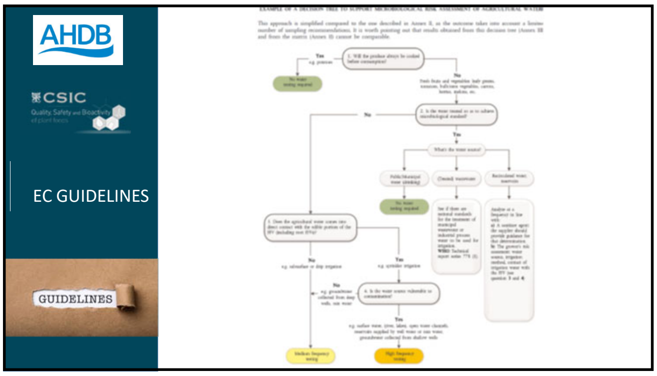

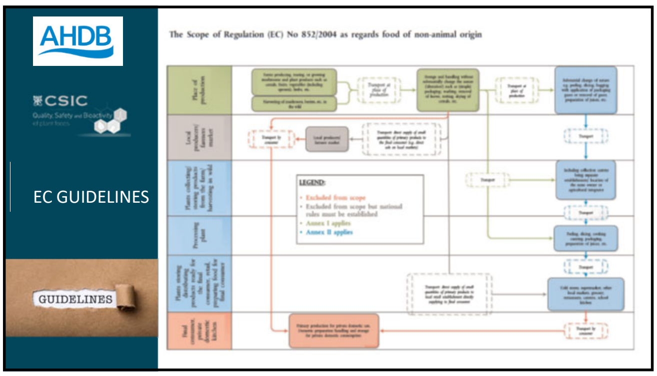

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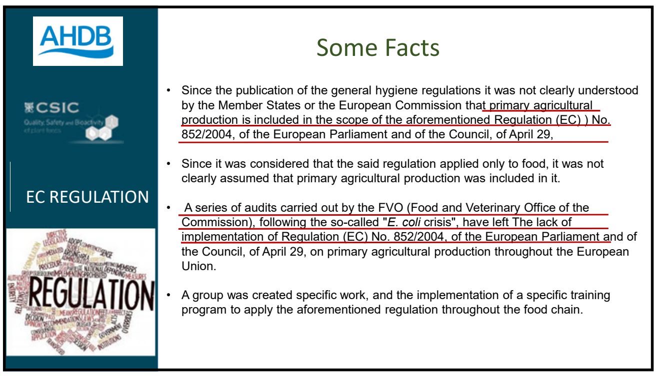

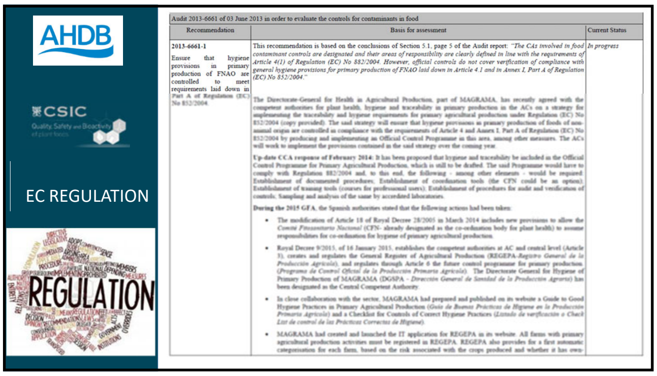

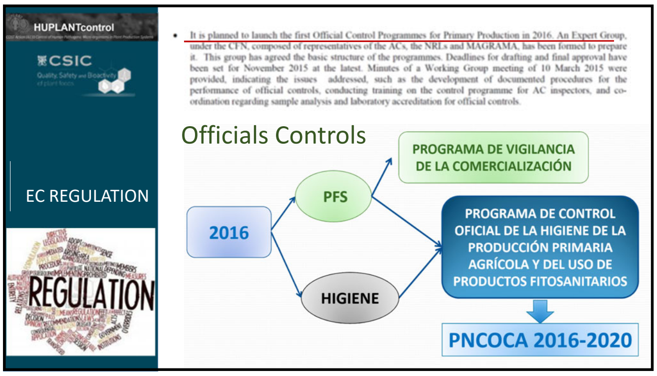

CCAA	CONTROLES MÍNIMOS A REALIZAR	EJEMPLO DISTRIBUCIÓN CONTROLES SEGÚN RIESGO			
		MUY ALTO	ALTO	MEDIO	BAJO*
Andalucía	1530	765	459	230	76
Aragón	315	158	95	47	15
Asturias	27	14	8	4	1
Baleares	31	16	9	5	1
Canarias	105	53	32	16	4
Cantabria	11	6	3	2	0
Castilla y León	614	307	184	92	31
Castilla-La Mancha	688	344	206	103	35
Cataluña	300	150	90	45	15
C.Valenciana	392	196	118	59	19
Extremadura	237	119	71	36	11
Galicia	223	112	67	33	11
Madrid	35	18	11	5	1
Murcia	252	126	76	38	12
Navarra	105	53	32	16	4
País Vasco	56	28	17	8	3
Rioja	79	40	24	12	3
ESPAÑA	**5000**	**2505**	**1502**	**751**	**242**

(*) En el redondeo, se han priorizado los riesgos más desfavorables

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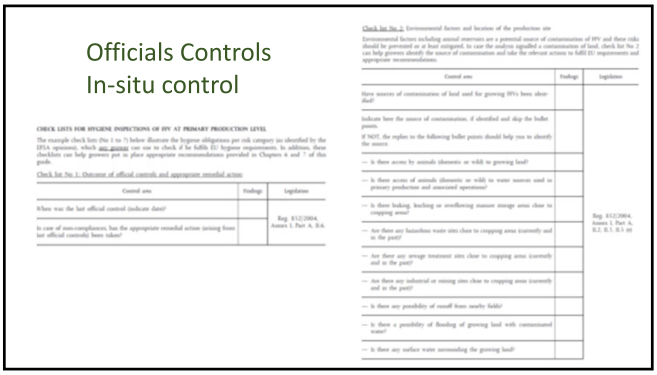

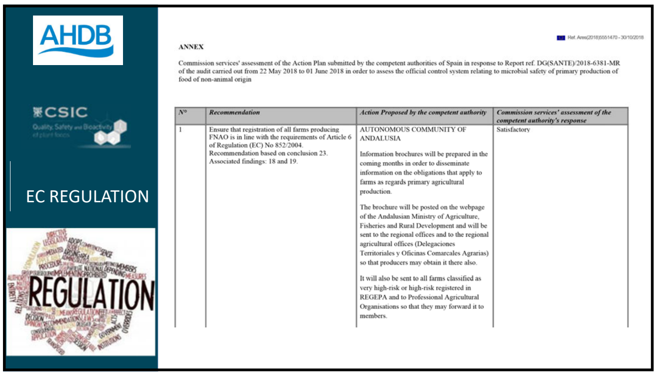

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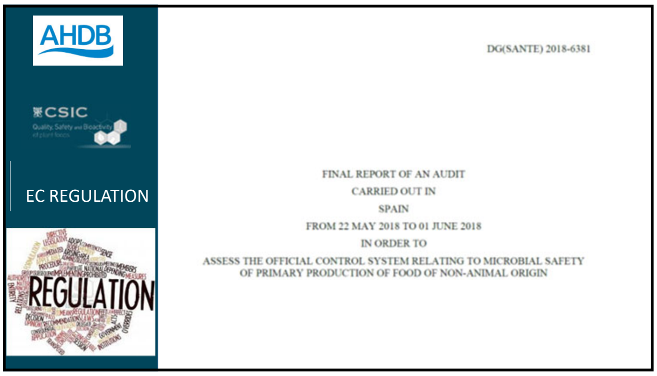

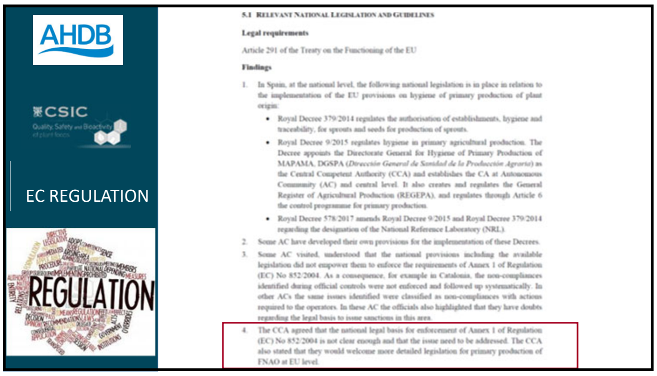

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Table 2: Number of official controls of FNAO in 2017

Autonomous Community	Nº controls planned	Nº controls implemented	Nº controls not planned	Nº controls total
ANDALUCÍA	1530	680	0	**680**
CATALUÑA	300	299	3	**302**
COMUNIDAD VALENCIANA	392	212	0	**212**
GALICIA	250	246	18	**264**
MURCIA	252	159	0	**159**

Conclusions on Organisation and Scope of Official Controls

36. There is an official control system in place covering primary production, supported by relevant IT tools for assessing risks and for the associated planning of controls, in compliance with the provisions of Article 3(1) of Regulation (EC) No 882/2004.

37. Based on the overall risk assessment and guidance at national level issued by MAPAMA, each AC plans the specific controls based on their own risk assessment relevant for the operators in their region and the crops grown.

82. Table 3: Number of official microbiological samples of FNAO in Spain analysed by the NRL

Year	No. of Samples	Analyses	Findings
2015	300 monitoring samples	pathogenic *E. coli* and ESBL *Salmonella* spp. *Listeria monocytogenes* *Campylobacter* spp.	no positive samples
2016	180 monitoring samples	pathogenic *E. coli* and ESBL *Salmonella* spp. *Listeria monocytogenes* *Campylobacter* spp.	1 sample positive for *L. monocytogenes*
2017	8 monitoring samples lettuce	*E. coli* *Listeria monocytogenes*	no positive samples
	60 monitoring samples strawberries	pathogenic E. coli and ESBL *Salmonella* spp. *Listeria monocytogenes* *Campylobacter* spp.	no positive samples
2018	6 official sprout samples	STEC *Salmonella* spp. *Listeria monocytogenes*	STEC detected in one sample

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Conclusions on Implementation of Official Controls over FBO Obligations

78. In all AC visited the official controls covered the relevant requirements concerning prevention of microbial contamination at primary production of FNAO within the scope of this audit. However, the significant shortcomings identified regarding follow-up of non-compliances and enforcement of adequate corrective actions do not ensure that the requirements of Article 54 of Regulation (EC) No 882/2004 are met. This could lead to not rectifying identified non-compliances regarding the relevant requirements for microbiological risk reduction.

79. Official controls on microbial safety in primary production of FNAO are not always executed in a consistent manner across and within the AC visited as required by Article 4 and 6 of Regulation (EC) No 882/2004.

80. Official controls of sprout-producing establishments are satisfactorily organised. There are however, shortcomings regarding the follow-up and enforcement of non-compliances in sprout producing establishments that do not ensure that the requirements of Article 54 of Regulation (EC) No 882/2004 are met.

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Non-potable wastewater reuse will alleviate water scarcity, says EU

29th May 2018

European Commissioner Karmenu Vella © Annika Haas (EU2017EE)

https://www.governmenteuropa.eu/ May 2018

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Reclaimed water

MINISTERIO DE LA PRESIDENCIA

21092 *REAL DECRETO 1620/2007, de 7 de diciembre, por el que se establece el régimen jurídico de la reutilización de las aguas depuradas.*

La Ley 11/2005, de 22 de junio, por la que se modifica la Ley 10/2001, de 5 de julio, del Plan Hidrológico Nacional, contiene una modificación del texto refundido de la Ley de Aguas, aprobado por el Real Decreto Legislativo 1/2001, de 20 de julio, en la que se ha dado nueva redacción del artículo 109.1 «el Gobierno establecerá las condiciones básicas para la reutilización de las aguas, precisando la calidad exigible a las aguas depuradas según los usos previstos. El titular de la concesión o autorización deberá sufragar los costes necesarios para adecuar la reutilización de las aguas a las exigencias de calidad vigentes en cada momento».

Se mantiene, sin modificación, el apartado 2 del artículo 109, en el que se recoge la obligación de obtener concesión administrativa que quedará sustituida por una autorización cuando quien solicite el aprovechamiento de las aguas depuradas sea el titular de la autorización de vertido que dio lugar a la depuración de dichas aguas.

USO DEL AGUA PREVISTO	VALOR MÁXIMO ADMISIBLE (VMA)				
	NEMATODOS INTESTINALES	*ESCHERICHIA COLI*	SÓLIDOS EN SUSPENSIÓN	TURBIDEZ	OTROS CRITERIOS
2.- USOS AGRÍCOLAS[1]					
CALIDAD 2.1[2] a) Riego de cultivos con sistema de aplicación del agua que permita el contacto directo del agua regenerada con las partes comestibles para alimentación humana en fresco.	1 huevo/10 L	100 UFC/100 mL Teniendo en cuenta un plan de muestreo a 3 clases[3] con los siguientes valores: n = 10 m = 100 UFC/100 mL M = 1.000 UFC/100 mL c = 3	20 mg/L	10 UNT	OTROS CONTAMINANTES contenidos en la autorización de vertido de aguas residuales: se deberá limitar la entrada de estos contaminantes al medio ambiente. En el caso de que se trate de sustancias peligrosas deberá asegurarse el respeto de las NCAs. *Legionella spp.* 1.000 UFC/L (si existe riesgo de aerosolización) Es obligatorio llevar a cabo la detección de patógenos Presencia/Ausencia (Salmonella, etc.) cuando se repita habitualmente que c=3 para M=1.000

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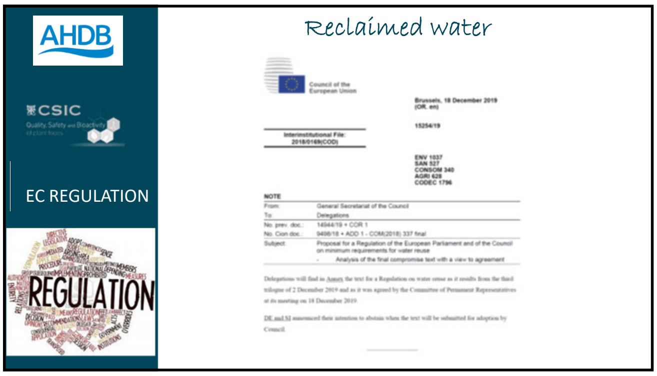
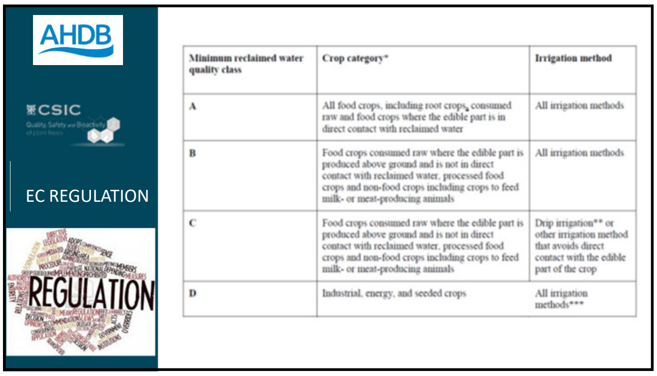




Minimum reclaimed water quality class	Crop category*	Irrigation method
A	All food crops, including root crops, consumed raw and food crops where the edible part is in direct contact with reclaimed water	All irrigation methods
B	Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops to feed milk- or meat-producing animals	All irrigation methods
C	Food crops consumed raw where the edible part is produced above ground and is not in direct contact with reclaimed water, processed food crops and non-food crops including crops to feed milk- or meat-producing animals	Drip irrigation** or other irrigation method that avoids direct contact with the edible part of the crop
D	Industrial, energy, and seeded crops	All irrigation methods***

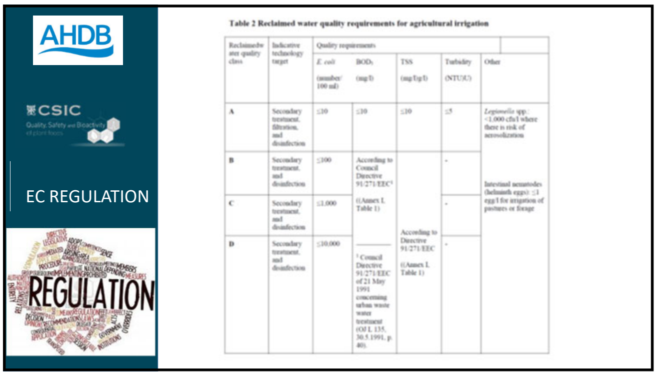


Table 2 Reclaimed water quality requirements for agricultural irrigation

Reclaimed water quality class	Indicative technology target	Quality requirements				
		E. coli (number/ 100 ml)	BOD_5 (mg/l)	TSS (mg/l)	Turbidity (NTU)	Other
A	Secondary treatment, filtration, and disinfection	≤10	≤10	≤10	≤5	*Legionella* spp.: <1,000 cfu/l where there is risk of aerosolization
B	Secondary treatment, and disinfection	≤100	According to Council Directive 91/271/EEC[1] (Annex I, Table 1)	According to Directive 91/271/EEC (Annex I, Table 1)	-	Intestinal nematodes (helminth eggs): ≤1 egg/l for irrigation of pastures or forage
C	Secondary treatment, and disinfection	≤1,000			-	
D	Secondary treatment, and disinfection	≤10,000			-	

[1] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste water treatment (OJ L 135, 30.5.1991, p. 40).

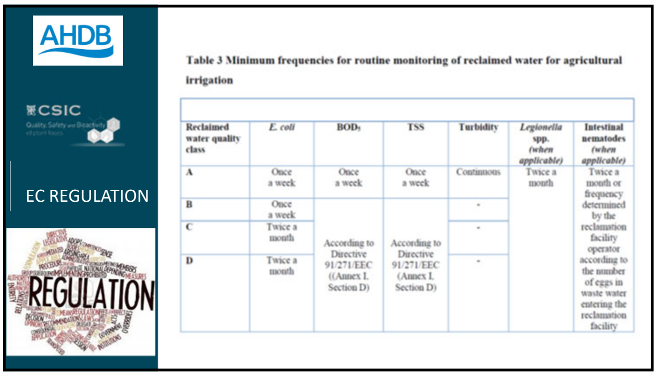


Table 3 Minimum frequencies for routine monitoring of reclaimed water for agricultural irrigation

Reclaimed water quality class	*E. coli*	BOD_5	TSS	Turbidity	*Legionella* spp. *(when applicable)*	Intestinal nematodes *(when applicable)*
A	Once a week	Once a week	Once a week	Continuous	Twice a month	Twice a month or frequency determined by the reclamation facility operator according to the number of eggs in waste water entering the reclamation facility
B	Once a week	According to Directive 91/271/EEC ((Annex I, Section D)	According to Directive 91/271/EEC (Annex I, Section D)	-		
C	Twice a month			-		
D	Twice a month			-		

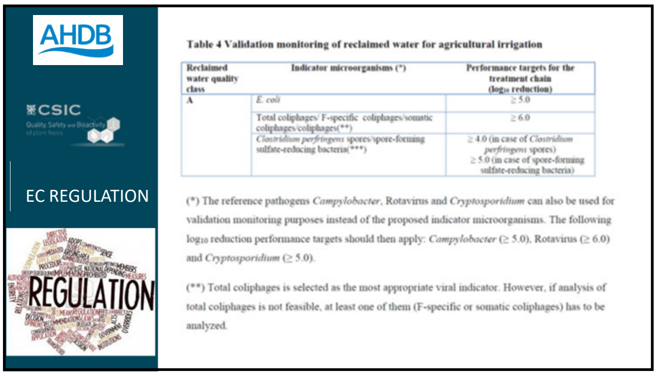
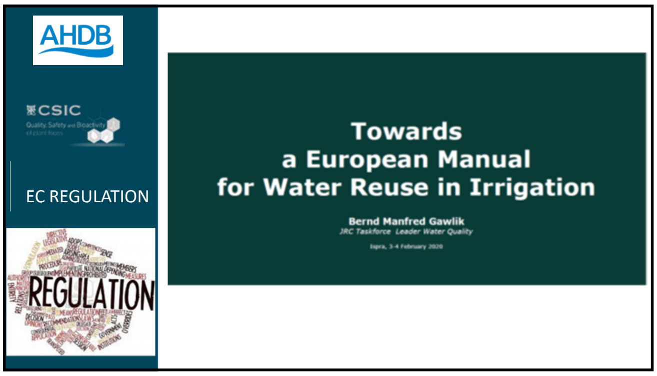


Table 4 Validation monitoring of reclaimed water for agricultural irrigation

Reclaimed water quality class	Indicator microorganisms (*)	Performance targets for the treatment chain (log_{10} reduction)
A	*E. coli*	≥ 5.0
	Total coliphages/ F-specific coliphages/somatic coliphages/coliphages(**)	≥ 6.0
	Clostridium perfringens spores/spore-forming sulfate-reducing bacteria(***)	≥ 4.0 (in case of *Clostridium perfringens* spores) ≥ 5.0 (in case of spore-forming sulfate-reducing bacteria)

(*) The reference pathogens *Campylobacter*, Rotavirus and *Cryptosporidium* can also be used for validation monitoring purposes instead of the proposed indicator microorganisms. The following log_{10} reduction performance targets should then apply: *Campylobacter* (≥ 5.0), Rotavirus (≥ 6.0) and *Cryptosporidium* (≥ 5.0).

(**) Total coliphages is selected as the most appropriate viral indicator. However, if analysis of total coliphages is not feasible, at least one of them (F-specific or somatic coliphages) has to be analyzed.



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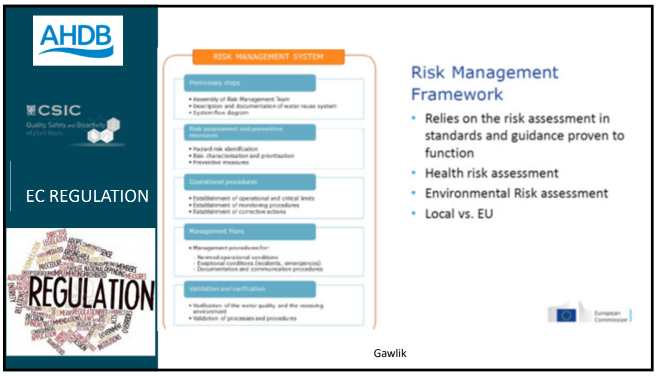

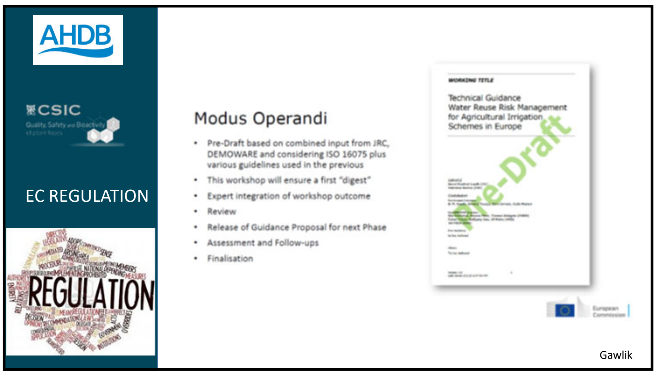

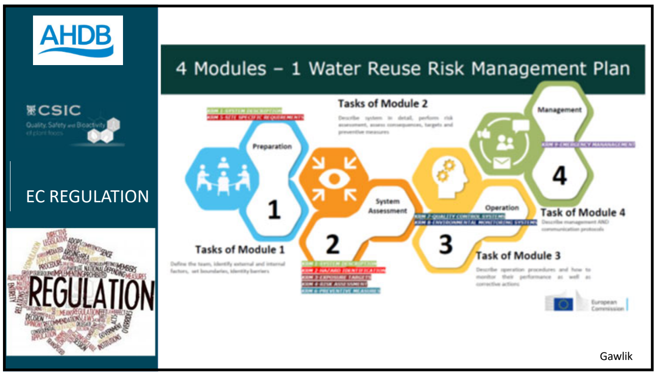

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Risk-based microbiological sampling plans in fresh fruit and vegetables production
Mieke Uyttendaele, University of Gent, Belgium

FACULTY OF BIOSCIENCE ENGINEERING

RISK BASED MICROBIOLOGICAL SAMPLING PLANS IN PRIMARY PRODUCTION

Liesbeth Jacxsens, Mieke Uyttendaele

Feb. 18-19th 2020 – EU COST 'HUPLANTcontrol' Microbials 'Keep it Clean' Workshop, Warwick, UK

Department of Food Technology, Food Safety and Health
Faculty of BioScience Engineering - Ghent University, Ghent, Belgium

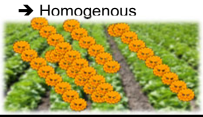
GHENT UNIVERSITY

MICROBIOLOGICAL CONTAMINATION IN FRESH PRODUCE

– Different contamination routes may lead to a different pattern in contamination

Point contamination
➔ Heterogenous

Overall contamination
➔ Homogenous



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MICROBIOLOGICAL CONTAMINATION IN FRESH PRODUCE

– To which type of contamination are leading following situations ?

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SPREAD OF CONTAMINATION DURING FURTHER PROCESSING ?

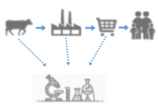
Contamination is concentrated in one package

Contamination is spread over multiple packages

WHO TESTS AND WHY

WHO TESTS AND WHY

Food business operators (FBOs)



Batch release

defined as testing using a pre-specified sampling plan for the purpose of accepting/rejecting the lot or batch.

Validation:

to determine (in advance) effectiveness of designed control measures and ensure food safety e.g. challenge testing to determine (thermal) inactivation or growth potential of MO in product/during production process

Verification:

gathering evidence to check/confirm (afterwards) if control activities are operating in practice e.g sampling to verify effectiveness of GAP or of cleaning and disinfection programs;.

Problem solving

Reinforced sampling and testing , as a corrective action in case of non compliant test results, persistent 'in- house' strain, complaints, foodborne outbreaks , etc microbial source tracking to determine the origin of contamination

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WHO TESTS AND WHY

Competent authorities (CA)

Batch release (as part of import control)
defined as testing using a pre-specified sampling plan for the purpose of accepting/rejecting the lot or batch

Baseline surveys
dedicated survey with a well established stratified sampling plan (defined food type, geographical region, stage in the food supply chain, (standard) method for sampling and analysis to collect baseline data => to collect representative sector-wide or nation-wide data on the status of microbial contamination

Monitoring (as part of Multi-annual National Control Plans in EU) (MANCPs)
routine microbiological analysis aimed at detecting microbiological contamination of food, often risk-based sampling. => useful prevalence data may emerge, but due to risk-based sampling often biased.

Surveillance
routine microbiological analysis aimed at detecting microbiological contamination of food for the purpose of applying appropriate control measures
=> to evaluate implemented control measures or mitigation strategies.

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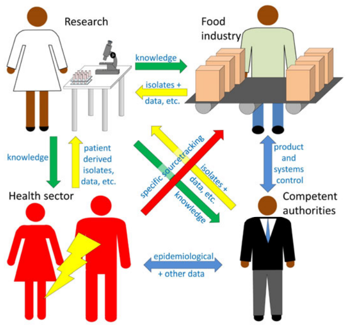
CA PROBLEM SOLVING: OUTBREAKS



Sekse et al. 2017. High Throughput Sequencing for Detection of Foodborne Pathogens. Frontiers in Microbiology: section Food Microbiology 8:2029. doi: 10.3389/fmicb.2017.02029

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SAMPLING & TESTING: FIRST THINK, THEN ACT !

Sampling (outside the lab)	Testing (in the lab)
Food categories - food composition - intrinsic product characteristics - packaging conditions - storage conditions - intended use - target population	**Sampling size** - x gram or cm² **Sampling procedure** - representative weight or surface area - dedicated (risk) based parts or areas - or using a rinsing procedure ?
Sampling stage - primary production / processing / distribution-retail - raw material or ingredient / half fabricate / end product / (production environment) - before or after (thermal) treatment or chilling etc.. - start / middle or end of production (batch) (day) or start / middle or end of shelf life	**Microbiological parameters** - quality - hygiene - safety **Method of analysis** Standard method or Rapid method or Expert/Research method

GHENT UNIVERSITY 6th March 2018 FMFP-UGent 2018 Book 'Microbiological Guidelines' 9

OBJECTIVES OF SAMPLING

Type of sampling design	Goals	User	Sample type
Batch control = acceptance sampling	Batch inspection	Government Industry	Product on the market Raw materials, Semi finished products, End Product
Monitoring & surveillance sampling	Detection of prevalence in a population	Government Sector associations industry	Product on the market
In-house risk- based sampling	FSMS/FQMS validation or verification	Industry	Incoming goods Production environment End Product

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MONITORING/SURVEILLANCE

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SURVEILLANCE / MONITORING SAMPLING

- Finding prevalance in large production amounts ➔ certain region, market, period of the year ?
- Statistical calculations to determine number of samples
- Research groups, government, sector associations
- Not that much for individual companies…

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NUMBER OF SAMPLES TO ESTIMATE A CERTAIN PREVALENCE

To estimate the prevalence of a defective/contaminant in a population?

$$n = \frac{Z^2 . p . (1 - p)}{L^2}$$

n = number of samples within a certain population

Z = 1.96 for 95% confidence (1,645 for 90%)

p = estimation of the prevalence (if known, if unknown we use 50% (0,50))

L = acceptance error or necessary precision (usually 5%)

You can **only use this formula** if **you have at least 10,000 units inside the batch** → again definition of a batch….(large batches or productions)

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NUMBER OF SAMPLES TO ESTIMATE A CERTAIN PREVALENCE

Scenario 1 – 95% confidence level

(Z = 1,96)

Number of samples **n** needed to estimate a determined prevalence with **95 % conficence level** (Z = 1,96) & **a precision of 5%** (L = 0.05)

$$n = \frac{Z^2 . p . (1 - p)}{L^2} = \frac{(1,96)^2 . 0,5 . (1-0,5)}{(0,05)^2} =$$

n = 384

We need **384 samples to determine the prevalence** (being expected 50%) with 95% confidence level and 5% precision

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BATCH SAMPLING

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OBJECTIVE OF SAMPLING

- Batch sampling ➔ rejection of acceptance of a batch:
  - What is a batch ?



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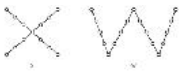
BATCH SAMPLING

- Field sampling




- Packed product



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BATCH SAMPLING

- Batch sampling ➔ rejection of acceptance of a batch:
  - Sampling design : multiple samples from same batch analysed individually ➔ maximising information….remember homogenous versus heterogenous contamination pattern….
  - E.g. EU Regulation on microbiological sampling EU Reg 2073/2005

Chapter 1. Food safety criteria

1.18	Sprouted seeds (ready-to-eat) ►M4 (7) ◄	Salmonella	5	0	Absence in 25 g	EN/ISO 6579	Products placed on the market during their shelf-life
1.19	Precut fruit and vegetables (ready-to-eat)	Salmonella	5	0	Absence in 25 g	EN/ISO 6579	Products placed on the market during their shelf-life
1.20	Unpasteurised fruit and vegetable juices (ready-to-eat)	Salmonella	5	0	Absence in 25 g	EN/ISO 6579	Products placed on the market during their shelf-life

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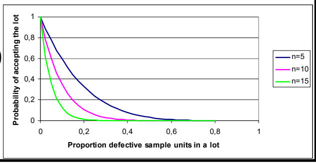
BATCH SAMPLING

- Batch sampling ➔ rejection of acceptance of a batch:
  - Sampling design : number of samples to be taken ?
  - The more are taken, the more information is available and better trust in decision to be taken about the batch
  - Typically : n = 5 or n = 10



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Product sampling at primary production ?

⇩

expected prevalence pathogens is low (0.1% to 1%?)

&

heterogeneously spread, localized contamination

⇩

Check Risk Factors !

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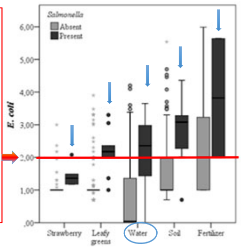
veg-i-trade

SAMPLING & TESTING: USE OF *E. COLI* AS INDICATOR ORGANISM FOR STEC & SALMONELLA

Action limit: use of E. coli

- **(irrigation) water**
  i) in direct contact with fruit/vegetable: 100 cfu/100 ml
  ii) *If no direct contact (drip irrigation)*: 1000 cfu/100ml
- **Veget./fruits (process hygiene crit 2073/2005)**:
  Preferably < 100 cfu/g
  Max. tolerance: 1000 cfu/g
  n = 5, c = 2



Analysis for *E. coli* & *Salmonella* in Belgium, Brazil, Egypt, Norway and Spain (n= 40/1605 Salm. positive)

Positive results for *Salmonella* were associated with higher *E. coli* counts
(in log CFU/g or 100 mL)

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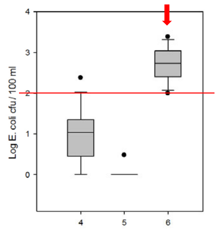
Reference: Ceuppens et al. 2015 Int. J. Environ. Res. Public Health.

WATER IN PRIMARY PRODUCTION



E. coli

4 = Lake
5 = Municipal water
6 = River

There were large variations of *E. coli* numbers depending on the water source.

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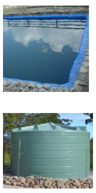
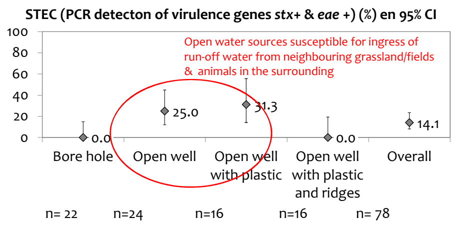
WATER IN PRIMARY PRODUCTION





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PhD Stefanie Delbeke Veg-i-Trade project, UGent 2014

MIXED FARMS: CATTLE & FRESH PRODUCE

STEC positives qPCR	STEC positives Culture	Farm	Sample type	Sampling time	Amount of E. coli
1	1	B	Substrate	14/09/2012	1,3 log cfu/g
2	2	B	Substrate	14/09/2012	1,3 log cfu/g
3	3	B	Water	14/09/2012	2,2 log cfu/100 ml
4	4	B	Water	14/09/2012	2,2 log cfu/100 ml
5	-	B	Water	14/09/2012	2,2 log cfu/100 ml
6	-	B	Water	14/09/2012	2,3 log cfu/100 ml
7	-	B	Water	4/07/2012	1,3 log cfu/100 ml

No STEC in the fresh produce !
↓
No contact between fruit/vegetable & substrate or the water!
↓
Drip irrigation !

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PhD Stefanie Delbeke Veg-i-Trade project, UGent 2014

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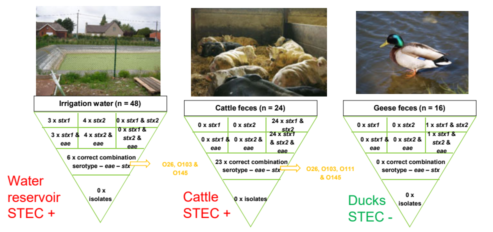
MIXED FARM – FOLLOW-UP TESTING



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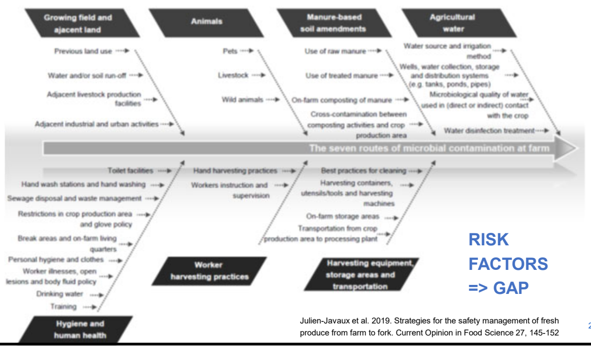

RISK FACTORS => GAP

Julien-Javaux et al. 2019. Strategies for the safety management of fresh produce from farm to fork. Current Opinion in Food Science 27, 145-152

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– Nestle supplier webpage to download the different booklets: https://www.nestle.com/aboutus/suppliers

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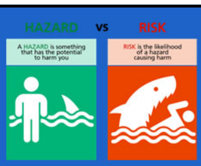
FROM HAZARD => RISK

RISK FACTORS => GAP => VERIFY



RISK BASED SAMPLING

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RISK BASED SAMPLING

- Verification of good practices, HACCP-based management system
  - ➔ sampling is not to only control measure….
- Prior knowledge ➔ selection of sampling locations/end products

Risk = probability x effect

- Different parameters defining the probability :
  - Prevalence (historical information, RASFF, etc.)
  - Presence and level of FSMS at supplier (certification level ?)
  - Communication potential with supplier (proactive, active, reactive)
  - Volume of product

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RISK BASED SAMPLING

- Scoring system and risk ranking

⇩

- High – medium – low risk level

⇩

- Number of samples per risk level

Lahou, Van Landeghem, Jacxsens, Uyttendaele. 2014. Microbiological sampling plan based on risk classification to verify supplier selection and production of served meals in food service operation. Food Microbiology 41, 60-75

Risk Level	Confidence level (%)	Positive fraction to be detected (%)	Total samples/ year
Low	90	10	23
Medium	90	5	46
High	95	2	149

- Also conducted by food safety authorities in multi-annual national control (MANC) plan to tailor official monitoring plans

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CONCLUSION : SAMPLING IS NOT EASY….

- Sampling design ➔ dependent on objective of sampling
- Batch sampling – acceptance sampling ➔ multiple samples from 1 batch
- Surveillance sampling ➔ detection of prevalence with certain confidence ➔ large production volumes, many samples because prevalence in food safety and quality defects is low due to implementation of FSMS/QMS and process control
- Risk based sampling ➔ risk ranking of environmental factors, end products ➔ low – medium – high and logical framework to determine number of samples

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⇨ SAMPLING IS ALWAYS TOO LITTLE TOO LATE !

SAMPLING IS ALWAYS TOO LITTLE TOO LATE !

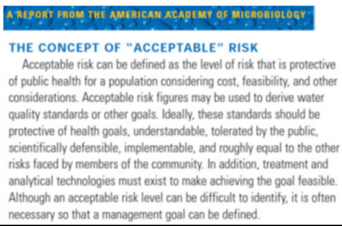
Zero risk does not exist !

The notion of "acceptable risk"

Determined by cultural factors, previous events, location (context), costs (willingness to pay)…

(Lechevallier & Buckley, Clean Water, AAM report, 2007)

ALARA
As Low As
Reasonable
Achievable


A REPORT FROM THE AMERICAN ACADEMY OF MICROBIOLOGY

THE CONCEPT OF "ACCEPTABLE" RISK

Acceptable risk can be defined as the level of risk that is protective of public health for a population considering cost, feasibility, and other considerations. Acceptable risk figures may be used to derive water quality standards or other goals. Ideally, these standards should be protective of health goals, understandable, tolerated by the public, scientifically defensible, implementable, and roughly equal to the other risks faced by members of the community. In addition, treatment and analytical technologies must exist to make achieving the goal feasible. Although an acceptable risk level can be difficult to identify, it is often necessary so that a management goal can be defined.

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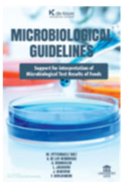
ENSURING FOOD QUALITY/ FOOD SAFETY



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Uyttendaele et al. 2018 Book 'Microbiological Guidelines'
https://www.diekeure.be/nl-be/professional/8831/microbiological-guidelines

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http://www.ugent.be/bw/en/contact
THANK YOU FOR YOUR ATTENTION!
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'Listeria monocytogenes and fresh produce'
Mike Hutchison, Hutchison Scientific

Listeria monocytogenes and fresh produce

Mike Hutchison

www.hutchisonscientific.com
Microbiological Food Safety Research and Consultancy

Listeria monocytogenes (Lm) – The basics

- Widely dispersed environmental bacterium
  - Cultivated soil, fresh surface waters, manure, this room, humans (10% carry it)
- Can be a human pathogen
  - Not much of a threat to most people
  - A good proportion of humans harbour Lm in our gut without issue
  - BUT vulnerable groups - elderly, pregnant women, immunocompromised - high morbidity and mortality
- Symptoms
  - Classic infection is of CNS – similar to meningitis
  - Immunocompromised also bacteraemia and septicaemia, spontaneous miscarriage of unborn children

Listeria monocytogenes (Lm)

- Never forget bacteria are dynamic and they evolve
  - Lm not a huge problem for fresh produce (sporadic)
  - Index case in Canada, mid 1980s. Cabbage fertilised with sheep manure and used to make coleslaw
  - Hard for healthcare professionals to track down sources. Incubation period up to 70 days

L. monocytogenes is psychrotrophic

- Grows at refrigeration temperatures
  - Even refrigeration is adequate some Lm strains will still grow
  - Freezing doesn't phase it either
- Ubiquitous in the environment, adapted to cold (especially surface water strains)
- Likelihood of human illness dependent on dose consumed

Classic contamination route

- *L mono* comes in to a plant on produce/ workers/ packing/ dust
- Contamination of processing environment
- Some strains are able to persist in the environment
- Establish residency in the processing environment
- Plant resident strains most likely to be final product (FP) contaminants
- Much rarer for produce strains to be isolated from FP (but it happens)

The importance of testing processing environments:

- Produce routinely contaminated
- Pack houses and processing areas under constant assault
- You can assume it's somewhere in your plant (drains) unless you've taken special measures
- Testing the plant environment lets you know a contaminated batch of product has been through
- Informs you that an exceptionally thorough clean (steamer) may be required to keep your products safe
- A legal requirement for RTE produce (Annex 1 of regulation EC 2073/2005) and processing environment testing (Article 5) that supports Lm growth

Hazard of cleaning using hoses

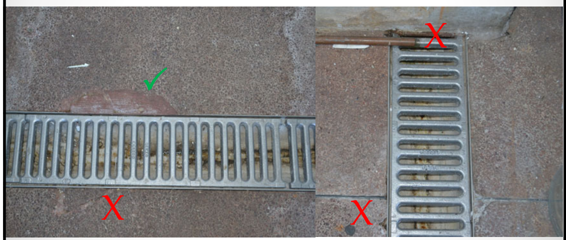
- Drains inoculated with *Listeria* (Berang and Franks, 2013)
- Sprayed with low pressure (~70kPa, a weak mains) tap water for 2 seconds
- Airborne *Listeria* were captured using an air sampler /settle plates placed around the drains.
- Listeria spp. was recovered from settle plates on the floor at distances of up to 4 m from the sprayed drain
- From walls as high as 2.4 m above the floor
- That's the mechanism for chiller ceiling contamination
- And why it's important to clean chiller ceilings and avoid condensation/drippage
- Uncontaminated chicken fillets became contaminated after being brought in to hall 10 minutes after 2 seconds hose use

High pressure hoses for cleaning are worse for generating aerosols

In other food industries

- No water used in processing areas
- Equipment removed to anterooms for cleaning
- Planned water flow in drains

Drains



Most effective sanitising agents for Lm

Sanitiser type	In the absence of food residues				In the presence of food residues			
	No. of studies reviewed	No. of observations	Total No. of replicates	Mean reduction (log cfu)	No. of studies reviewed	No. of observations	Total No. of replicates	Mean reduction (log cfu)
Acid-anionic	3	39	78	7.1	1	4	32	5.3
Halogen	3	27	124	3.8	2	9	60	2.4
Hypochlorite	11	321	891	5.5	4	38	117	2.8
Peracetic acid	6	177	484	4.6	2	24	52	3.8
Quaternary ammonium	5	59	262	6.1	2	8	56	5.3

https://doi.org/10.1016/j.ijfoodmicro.2012.05.019 (2012) original source

https://doi.org/10.1007/s10123-018-0002-5 (2018) as check still valid, peracetic acid did well, limited number of Lm used

Increasing resistance in Lm to sanitiser

- Emergence of food-related bacteria that are resistant to QAC observed for at least fifteen years
- Resistance not confined to QAC
- Sub-lethal exposure to sanitising compounds in biofilms
- Resistance to QAC-based disinfectants are more prevalent among food-borne *L. monocytogenes* isolates than isolates from pools of human, animal, faecal and environmental (e.g. soil) sources.

DOI: 10.1016/S0964-8305(98)00027-4
DOI: 10.1016/S0964-8305(03)00044-1

Good practices to curtail LM resistance

- Recommend that it is a good practice to periodically change the active agent in their sanitiser to help prevent the spread of increasingly resistant *L. monocytogenes*.
- Scrubbing physically abrades biofilms
- Try not to apply sanitiser to wet surfaces – it dilutes the chemical (or use stronger concentration to take account)
- Many processors in hard water areas inadvertently achieve a periodic one time chemicals change by using an acid based sanitiser every few weeks, primarily to remove lime scale from equipment.
- Steady creep upwards to the MICs over last 10 years. In another decade resistance may be a credible issue

Assessing irrigation water for contamination risks

Jim Monaghan

Overview

- How useful is a test?
- When to test and how frequently
- How to collect the water
- What tests to request
  - Indicators
- What to do with the results
  - Corrective actions
- Validating water treatment kit

QAS - 1st Generation

- Assured Produce – early 1990s
- EurepGAP –1997
- Tesco Natures Choice - 1992
- M&S Field to Fork – 2004*

1. You need systems in place to make it safe
2. HACCP principles
3. Risk assess water sources and use
4. *Test water for *E.coli*

QAS – 2nd Generation

- Red Tractor Fresh Produce
- GlobalGAP
- Tesco Nurture
- M&S Field to Fork v2

1. You need systems to make things safe
2. HACCP principles
3. Risk assess water sources and use
4. Critical values for *E.coli*
5. Guidance on RA methodology

Harper Adams University

QAS – 3rd Generation

- McDonalds GAP (US FDA standard)

1. You need systems to make things safe
2. HACCP principles
3. Risk assess AND METRICS for water sources and use
4. Critical values for *E.coli*
5. Guidance on RA methodology

Harper Adams University

What can a test tell you?

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Test timing relates to risk

- What does your customer/QA scheme want?

Some indication of best practice for testing frequency

- Red Tractor –
- Low risk = annual
- Moderate risk = 2 / year (1 before harvest)
- High risk = Monthly (2 before harvest)
- USDA - 5 samples must be taken within the leafy crop growth period or 30 days

M&S Field to Fork Acceptable Water Source Matrix

Irrigation Water Source/ Use Table (post-harvest water must be potable)

	Cat 0	Cat 1 crops	Cat 2	Cat 3	Cat 4 crops	
Potable mains water (from water authority)	**Approved** certificate of potability.	**Approved** Should hold a certificate of potability.	**Approved** Should hold a certificate of potability.	**Approved** Should hold a certificate of potability.	**Approved** Should hold a certificate of potability.	Water from local authorities should not show any e-coli.
Borehole/ Spring water	**Not permitted**	**Requires testing** data verification (test 3x year or 1x with 5 yr testing history)	**Requires testing** data verification (3x per year or 1x with 5 yr testing history)	**Approved** (test 1x per year)	**Approved** (test 1x per year)	Water from boreholes should not show e-coli provided the outlet is clean and protected from contamination
Contained surface e.g. reservoir	**Not permitted**	Trusted water source Or not food contact (test 1x per month)	Trusted water source or not food contact (3 x per year)	**Approved** (test 1x per year)	**Approved** (test 1x per year)	Surface water is expected to have low levels of e-coli which may vary over the season
Free-flowing surface e.g. river	**Not permitted**	**Not permitted** – unless no food contact or treated (e.g.UV) or adherence to 'High Risk Water Source Use Checklist'		**Approved** (assess water source for animal or human contamination risk)	**Approved** (assess water source for animal or human contamination risk)	River water is likely to contain variable levels of e-coli, depending on human or animal presence/ activity upstream.
Water test results E.coli cfu sampled in 100ml of irrigation water		• Target = absence • Acceptable <100 • Monitor 100-1000 re-test • Unsatisfactory 1000= do not use and investigate and report to M&S Technologist.	• Target = absence • Acceptable <100 • Monitor 100-1000 re-test • Unsatisfactory 1000; investigate and report to M&S Technologist.	• Target = absence • Acceptable <100 • Acceptable 100-1000 but investigate • Monitor >1000	• Target = absence • Acceptable <100 • Acceptable 100-1000 but investigate • Monitor >1000	

EFSA recommendation

Intended use of the water	Source of water							Recommended limits of *E. coli* as an indicator of contamination
	Untreated surface water	Untreated ground water collected from shallow wells (<50m)	Untreated ground water collected from deep wells (≥50m)	Untreated rain water	Treated[1] sewage water	Disinfected water (from any source but disinfection treatment well controlled and monitored)	Municipal water (potable water)	
PRE-HARVEST and HARVEST								
Irrigation of crops likely to be eaten uncooked (i.e ready-to-eat FFV) (irrigation water comes into direct contact with the edible portion of the crop) Pesticide dilution and cleaning equipment for ready-to-eat FFV								100 CFU/100ml
Irrigation of crops likely to be eaten cooked (irrigation water comes into direct contact with the edible portion of the crop). Pesticide dilution and cleaning equipment used in this crop.								1.000 CFU/100ml
Irrigation of crops likely to be eaten cooked (irrigation water does not come into direct contact with the edible portion of the crop). Pesticide dilution and cleaning equipment used in this crop.								10.000 CFU/100ml
POST-HARVEST								
Cooling post-harvest and transport post-harvest and cleaning equipment and surfaces where the products are handled in case of ready-to-eat products..								100 CFU/100ml
Washing and cleaning FFV and ice for cooling applied for ready-to-eat FFV	ONLY POTABLE WATER							Requirements of the potable water

Key to EFSA chart

- **RED**: should not be used.
- **ORANGE**: shall be used with restriction on sampling.
- **YELLOW**: shall be used with restrictions on sampling.
- **GREEN**: can be used without any restrictions and without analysis.

Harper Adams University

RTFP water matrix – derived from EFSA matrix

Harper Adams University

RTFP - simplified

Category	Potential contact with the edible portion of crop	Mains	Treated/ disinfected	Rainwater	Bore hole/well	Surface river/canal	Reservoir	Indicator threshold CFU/100ml
0 = micro leaves and salad cress	Direct contact	Annual	Monthly					<10
	No direct contact							
1 = Leafy salads, herbs, strawberries	Direct contact	Water board test certificate	Annual	2 / year	2 / year	Monthly	Monthly	<100
	No direct contact		Annual	2 / year	2 / year	2 / year	2 / year	<1000
2 = Brassicas, legumes, carrots	Direct contact		Annual	2 / year	2 / year	Monthly	Monthly	<1000
	No direct contact			Annual	Annual	2 / year	2 / year	<1000
3 = Potatoes	Direct contact		Annual	Annual	2 / year	2 / year	2 / year	<1000
	No direct contact				Annual	Annual	Annual	<10,000

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How to take a water sample

- Representative
  - Run the water through
  - Do not contaminate the bottle or lid
  - Send the sample quickly
- KIC DVD from 2005

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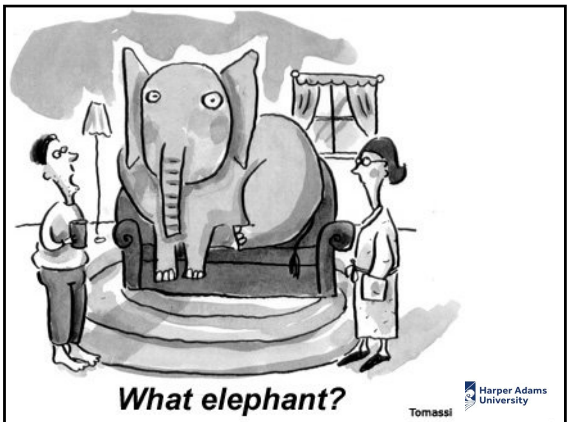

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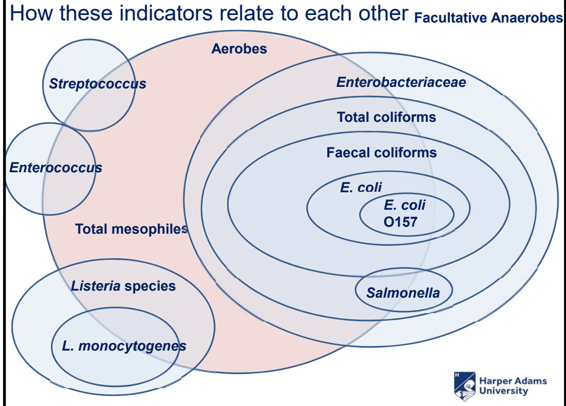
E.coli is not a pathogen test

- The presence of generic E.coli provides evidence of an increased likelihood of potential contamination of food or water by ecologically closely related pathogens (Uyttendaele et al 2015)
- It is the best, cheap, guide to water safety we have.

What is an indicator?

- NOT a pathogen test
- E.coli most common
  - From animal (and human) guts
  - 'travels' with faeces
- INDICATES the level of faecal contamination of the growing system

How these indicators relate to each other



E.coli

- **Not really the same as O157**
- Indicates presence of animal or human faecal material in water or on fresh produce
- Most strains do not survive for long in water or the environment so indicates a recent contamination event
- After rain, numbers of E. coli in river water increases

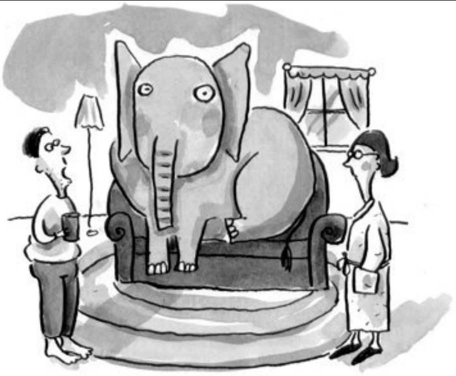
Coliforms and Faecal coliforms

- Both provide similar information to an *E. coli* count = contamination with Faeces
- High percentage of coliforms are *E. coli*
- With time E. coli loses the ability to grow at enteric temperatures so higher incubation temperature for FC

What to do with the results

- Know your critical limits
- Trend your results
- Have you thought about corrective actions before you need them
  - What are they?

Assessing irrigation water for contamination risks
Jim Monaghan, Harper Adams University



What elephant?

Tomassi

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What does testing show?

Table 1. Enumeration of microbial indicators and prevalence of foodborne pathogens in water used to irrigate fresh produce in Europe.

Country	Produce	Water Source	Microorganisms	Average cfu/100 mL	Prevalence	Reference
Belgium	Strawberry	Groundwater	STEC	–	0/22	Delbeke *et al.*, 2015
			E. coli spp.	1	4/22	
		Rainfall water collected in ponds	STEC	–	11/56	
			E. coli spp.	40–45	40/56	
Belgium	Lettuce	Rainfall water collected in open wells and bore hole water	STEC	–	6/68	Holvoet *et al.*, 2014
			Campylobacter spp.	–	37/120	
			Salmonella spp.	–	1/68	
			E. coli spp.	30–35	90/120	
Spain	Baby spinach	Surface water collected in water reservoirs	STEC	–	0/50	Castro-Ibañez *et al.*, 2015
			Salmonella spp.	–	1/50	
			E. coli spp.	5–10	72/250	
Spain	Tomatoes	Surface water	STEC	–	0/16	López-Gálvez *et al.*, 2014
			Salmonella spp.	–	1/16	
			E. coli spp.	20–25	6/32	
			Listeria spp.	30–35	26/30	
		Reclaimed water	STEC	–	0/16	
			Salmonella spp.	–	2/16	
			E. coli spp.	240–280	31/32	
			Listeria spp.	350–400	26/30	
Italy	Tomatoes	Tap water	*E. coli* spp.	–	0/30	Forslund *et al.*, 2012
		Reclaimed water	*E. coli* spp.	10,300	11/30	
Crete	Tomatoes	Tap water	*E. coli* spp.	400	2/31	
		Reclaimed water	*E. coli* spp.	596	4/31	

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Spatial-temporal variations of microbial water quality in surface reservoirs and canals used for irrigation

Gayeon Won, Terence R. Kline, Jeffrey T. LeJeune*
Food Animal Health Research Program and Ohio Agricultural Research and Development Center The Ohio State University 1680 Madison Ave Wooster, OH 44691, United States

n>5 canal and n>14 reservoir samples needed to calculate E. coli concentrations at precision level of 85% with 95% confidence interval ***under same environmental conditions during the testing period***.

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Validation testing

- No formal standards
- Best practice developing
  - – Annual validation
  - – Regular monitoring
  - – Wider range of indicators

UK Best practice example

Water Treatment Validation

Validation Requirements

1. All new equipment must be validated to verify its ability to reduce microbial loading – minimum acceptable reduction - target 3 log
2. All existing equipment should be validated before the beginning of the season
3. During production season ongoing efficacy should be validated mid season

Validation Process

- Equipment should be switch on and allowed to operate for minimum of 15 minutes – ensure pre filtration is in place and operating effectively
- Run water through sample taps for min 2 minutes before sampling
- At defined intervals 3 samples should be taken of untreated water and 3 of the treated water as close as possible.

Time	Number samples Untreated	Number Samples treated
15 minutes	3 samples	3 samples
30 minutes	3 samples	3 samples
60 minutes	3 samples	3 samples

- Samples should be tested from
  - TVC at 22oC
  - TVC at 37oC
  - Enterobacteriaceae
  - Coliforms
  - E coli or Faeca strep
- Results should be documented and fully enumerated to validate efficacy of equipment, use of a scatter graph to visually demonstrate reduction can be used
- Process should be repeated once mid season with one pre and post treatment sample to demonstrate the continuing operational efficacy

We want clean water – potable?

- Challenges
  - – Multi sources of water
  - – How do you know it is safe (at point and time of irrigation)
- Treatment is becoming the ideal BUT difficult
  - – Need high volume treatment
  - – Robust kit
  - – Cheap kit
  - – Effective

What does the future look like?

- Frequency of water testing is much higher
- Standards are harder to achieve (impossible?)
- Looking for a systems to clean water and/or product

Trending bacterial numbers

Mike Hutchison

www.hutchisonscientific.com
Microbiological Food Safety Research and Consultancy

The basic concept

- Take a water sample
- Send it to a lab for testing
- Obtain a numerical result
- What do you do with the result?

- …. And your historic dataset?

The basics of trending

- Choose your indicator
  - Common ones are:
    - *E. coli*
    - *Enterobacteriaceae*
    - *Coliforms/ faecal coliforms*
    - *Streptococcus and enterococcus*
    - TVC (TAMC)

- Once chosen, stick with it
- You can't 'mix and match' different indicators

The basics of trending

- How representative is a 250ml sample once a year from something like this?

The basics of trending

- Think about taking multiple samples
  (I know cost is an issue)

- Close together (minutes to hours)
- From different areas of the river/lagoon/store

- Floats and where the water is taken from

Good practices
- Get them to the lab quickly – keep cool, less than 4 h
- Use bottles containing thiosulphate

The basics of trending

- Numbers in microbiology get big quickly
- So log all your test results:

- A set of results 100 cfu/100ml, 150 cfu/100ml, 230 cfu/100ml, 1500000 cfu/100ml

- Regular mean:

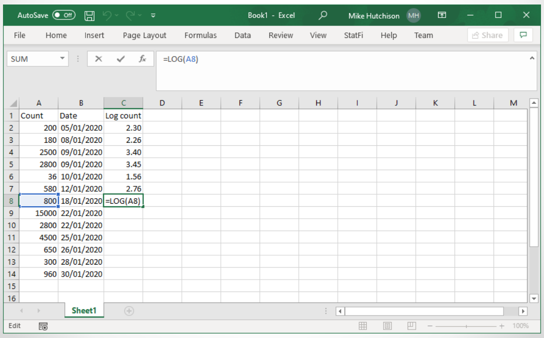
100+150+230+1500000 = 1500480/4 = 375,120 cfu/100ml

- Geomean – take log10 of the numbers then calc the mean
- 2+2.18+2.36+6.18 = 12.72/4 = 3.18 (about 1500 cfu/100ml)

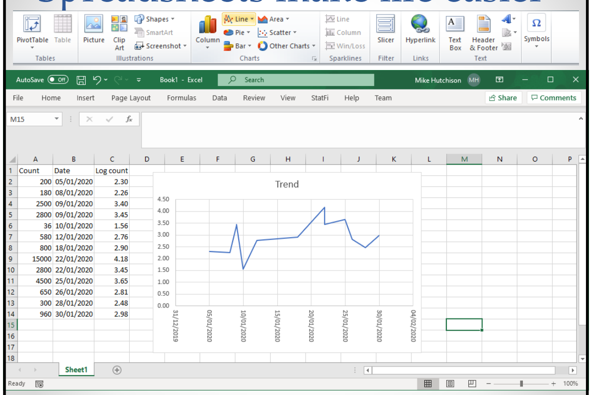
Niggles from the lab

- A result reported as <50 cfu/100ml
- Means the test method has a limit of detection of 50 cfu/100ml
- Substitute half the limit of detection – 25 cfu/100ml
- TMTC, >100000 cfu/100ml, unable to determine
- Think hard before using water like that
- For trending substitute upper LoD +1

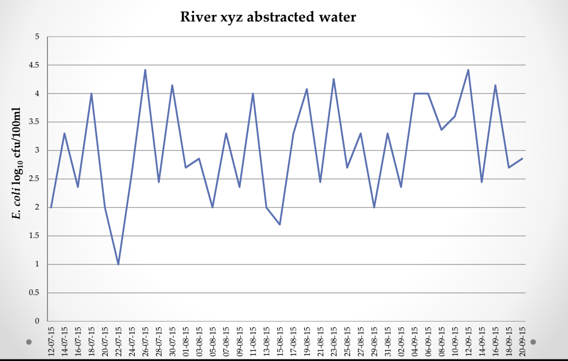
Spreadsheets make your life easier



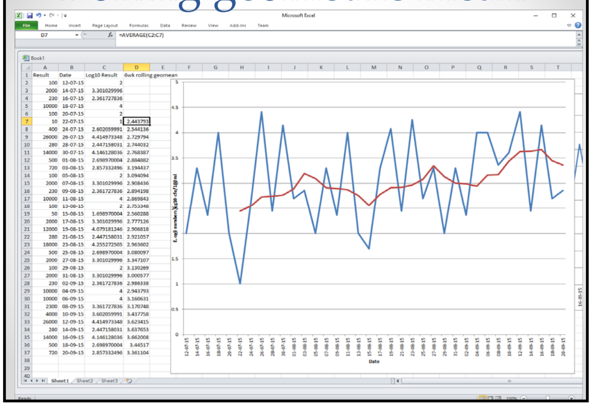
Spreadsheets make life easier



Messy trends and what to do

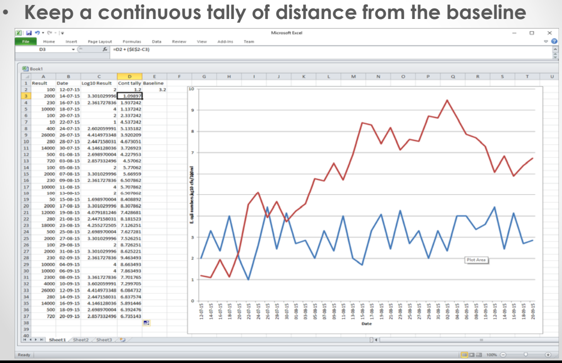


Rolling geometric mean



More than one way to handle

- Set a baseline (~5-10 test results, depends on variation)
- Keep a continuous tally of distance from the baseline



Delegate List

	Surname	Name	Business
1	Ackroyd	Maria	Gs Ltd
2	Agnew	Emma	Food Standards Scotland
3	Allende	Ana	CEBAS-CSIC
4	Alsanius	Beatrix	Swedish University Dee Agricultural Sciences
5	Andrews	Teresa	AHDB
6	Arkell	Paul	PDM produce Ltd
7	Ashton	Paul	International Water Solutions Ltd
8	Banach	Jennifer	Wageningen Food Safety Research (WFSR), part of Wageningen University & Research
9	Bartkowski	Adam	G Thompsons
10	Bloom	Roger	Berry Gardens
11	Boyle	Terri-Ann	International Water Solutions Ltd
12	Burgess	Kaye	Teagasc
13	Cameron	Niall	Bakkavor Limited
14	Choto	Grace	AHDB
15	Colagiovanni	Lauren	AHDB
16	Coller	Abby	East Coast Growers Ltd
17	Comrie	Crawford	Kettle Produce Ltd.
18	Dimitrov	Kaloyan	Valefresco
19	Edwards	Tomos	PDM produce Ltd
20	Falayi	Taiwo	Growing Underground
21	Feege	John	Coop Food Group
22	Finch	Liz	Jepco
23	Floyd	Caroline	Bakkavor
24	Gaffney	Michael	Teagasc
25	Gammond	Helen	Agrial Fresh Produce
26	Gibbs	Robert	Langmead farms ltd
27	Gil	Mabel	CEBAS-CSIC
28	Goodburn	Karin	Chilled Food Association

	Surname	Name	Business
29	Goodman	Melissa	Produce World
30	Grant	Connor	Sandfields Farms Ltd
31	Groves	Owen	Valefresco Ltd
32	Hall	Adam	G's Growers
33	Hargreaves	Jacob	Food Standards Scotland
34	Harris	Jackie	Valefresco
35	Harrison	Ben	IPL (Asda)
36	Harvey	Gareth	Springhill Farms
37	Holmes	Charles	Blackdown Growers
38	Hutchison	Mike	Hutchison Scientific Ltd
39	James	Rob	Thanet Earth
40	Karacholova	Rayna	Springhill Farms
41	Kemp	Tom	International Water Solutions Ltd
42	Kennedy	David	JEPCO Ltd
43	Key	Nathalie	AHDB
44	Kingdon	Stephen	PDM produce Ltd
45	Kotecha	Miya	AHDB
46	Langley	Philip	Sandfields Farms Ltd
47	Lockwood	Adam	Lockwood Salads
48	Lotfi	Fki	Faculty of Sciences of Sfax Tunisia
49	Luckhurst	Ellis	Riviera Produce Ltd
50	Markovskis	Sergejs	PDM produce Ltd
51	Masica	Ivo	Valefresco
52	Mawer	Keith	Strawson Limited
53	Mawer	Keith	Strawson Limited
54	McFarlane	Dennis	Watts Farms
55	Mcmillen	Matty M	PDM produce Ltd
56	Mirzaee	Mehrdad	Landseer Ltd
57	Monaghan	Jim	Harper Adams
58	Morley	Philip	APS Produce Ltd

	Surname	Name	Business
59	Napier	Bruce	NIAB
60	Napior-Kowska	Stasha	AHDB
61	Nellies	Mike	Kettle Produce Ltd
62	Nowak	Piotr	The Lettuce Company
63	Oakes	Anthony	Agrial Fresh Produce
64	Odey	Penny	Puffin Produce Ltd
65	Riding	Oliver	Process Instruments
66	Roberts	Steven	Plant Health Solutions Ltd
67	Robinson	Tracy	Sandfields Farms Ltd
68	Sacha	Uwais	IPL
69	Sayed	Al	International Water Solutions Ltd
70	Singh	Jas	Vicarage Nurseries
71	Smith	Geoffrey	Mapleton growers ltd
72	Starzynski	Radoslaw	Vicarage Nurseries
73	Stephenson	Nathan	International Water Solutions
74	Stoilova	Galya	PDM produce Ltd
75	Swayne	Gary	APS Produce
76	Taylor	Gareth	Gareth Taylor Contracting
77	Taylor	James	AHDB
78	Thompson	Jim	Stourgarden
79	Thomson	David	Berry Gardens Growers Ltd
80	Uyttendaele	Mieke	Ghent University
81	van der Hut	Gerard	Rijk Zwaan UK Ltd
82	van Overbeek	Leo	Wageningen University and Research
83	Walker	Nick	Agrial Fresh Produce
84	Watson	Rob	Sandfields Farms Ltd
85	Whiteman	Matthew	Springhill farms Ltd
86	Wilde	Harry	Jepco Marketing Ltd
87	Wilson	Debbie	AHDB
88	Wood	Barbara	Len Wright Salads