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Food Safety Management for Fresh Produce

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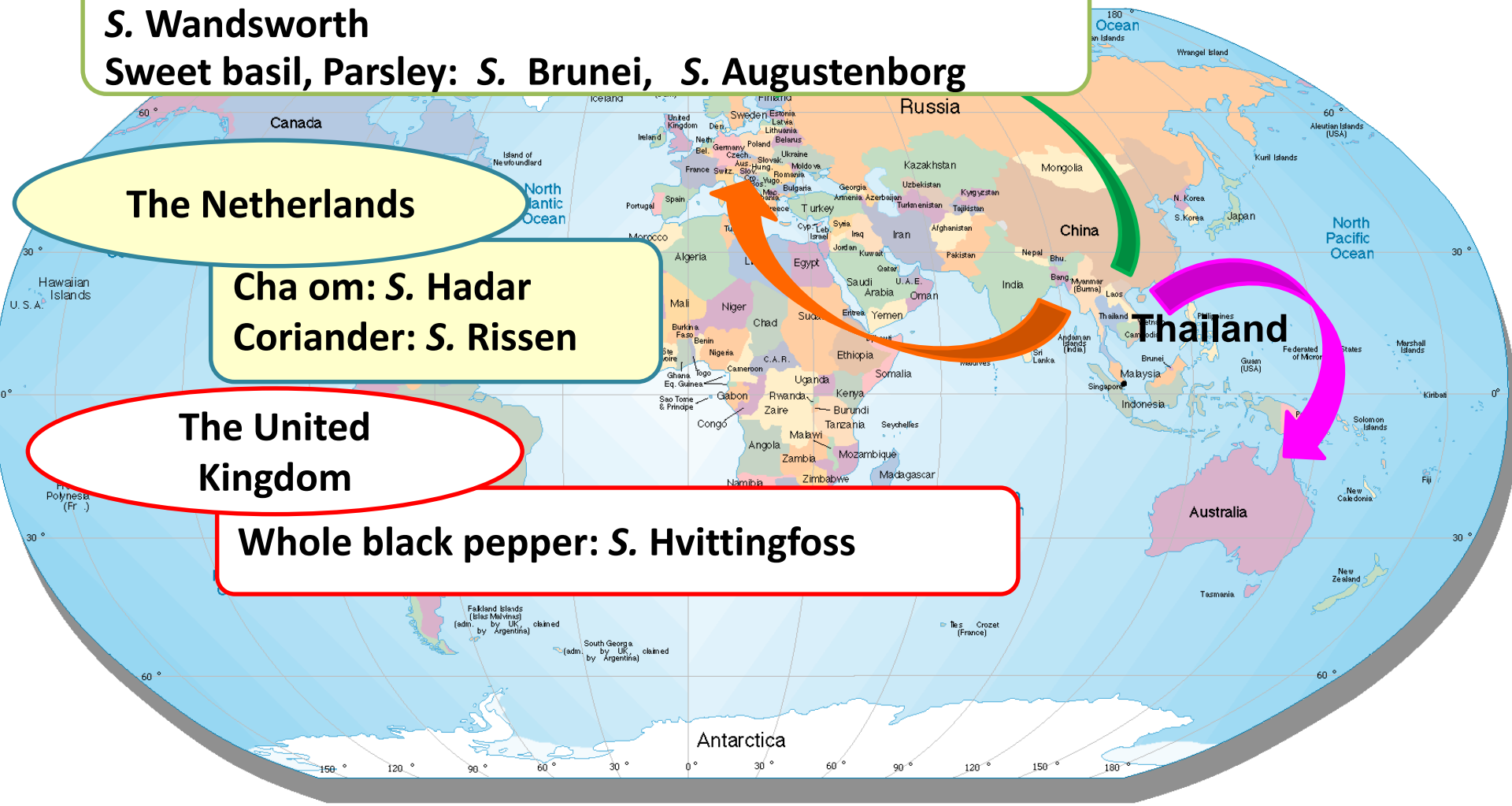
Food safety management for fresh produce

- Food safety issues in fresh and fresh cut produce
- Food safety management in produce production in Thailand
- Microbial hazards
  - Remove of pathogens using various sanitizers
- Chemical hazards
  - Remove of pesticides using oxidizing agents

Finland

Fresh leaf vegetable: *S.* Ndolo, *S.* Bovismorbificans, *S.* Wandsworth
Sweet basil, Parsley: *S.* Brunei, *S.* Augustenborg



Cha om: *S.* Hadar
Coriander: *S.* Rissen

The Netherlands

The United Kingdom

Whole black pepper: *S.* Hvittingfoss

เอกสารประกอบ : รายการสารตกค้างในสินค้าเกษตร-อาหารที่ EU ตรวจพบ เดือนกุมภาพันธ์ 2552

(ข้อมูลจาก ALERT NOTIFICATION)

รายการ	วันที่	ประเทศที่แจ้งพบสารตกค้าง	รายการสารตกค้าง	สินค้านำเข้าจากประเทศ
1	2/02/2009	Netherlands	Salmonella in Asiatic pennywort	Thailand
2	2/02/2009	Poland	Salmonella in soybean meal	Argentina
3	2/02/2009	Italy	carbon monoxide treatment of frozen slices of swordfish	Netherlands
4	2/02/2009	Netherlands	Salmonella in praew leaf	Thailand
14	4/02/2009	Finland	carbofuran, prophenophos, ethion, triazophos , omethoate and dimethoate in fresh coriander	Thailand
15	4/02/2009	Italy	presence of bacterial inhibitor (penicillin group) in pasteurized milk	Austria
16	4/02/2009	Germany	unauthorised placing on the market of herbal infusion containing Senna leaves	Vietnam
17	4/02/2009	Italy	imazalil in lemons	Argentina
18	5/02/2009	Malta	high number of aerobic plate counts in purified drinking water	Malta
19	5/02/2009	Spain	aflatoxins in roasted pistachios	Spain
20	5/02/2009	Norway	unauthorised placing on the market of flavoured green tea containing Senna and Garcinia (Sennae folium, Sennae fructus and Garcinia atroviridis)	Thailand
21	5/02/2009	Germany	aluminium in instant noodles	China
22	5/02/2009	Norway	unauthorised placing on the market of herbal infusion containing Senna (Sennae folium and Sennae fructus)	Thailand

ไทยมีโรงคัดบรรจุล่าสุด ๑๔ รายแล้ว ณ วันที่ ๒๙ พฤษภาคม ๒๕๕๕

Contributed by สำนักงานที่ปรึกษาการเกษตรต่างประเทศ ประจำสหภาพยุโรป
Wednesday, 13 June 2012

เพื่อแก้ไขปัญหาการส่งออกผักไทยไปยังสหภาพยุโรปที่มีขึ้นตั้งแต่ต้นปี พ.ศ. ๒๕๕๔ ณ วันที่ ๒๖ มีนาคม ๒๕๕๕ กรมวิชาการเกษตรได้ดำเนินมาตรการควบคุมพิเศษระบบบัญชีรายชื่อโรงคัดบรรจุ (Establishment list) โดย วันที่ ๒๙ พฤษภาคม ๒๕๕๕ ไทยมีโรงคัดบรรจุที่ผ่านการพิจารณาตามหลักเกณฑ์มาตรการที่กำหนดเป็นจำนวนรวม ๑๔ รายแล้ว โดยมีโรงคัดบรรจุของบริษัท ลองเทอม เทรดดิ้ง จำกัด พาร์ท จำกัด เป็นรายล่าสุด ติดตามรายละเอียดได้ดังนี้

๑.๑ โรงคัดบรรจุของบริษัท สวิฟท์ จำกัด พืชที่ผ่านการพิจารณา ได้แก่ กะเพรา โหระพา มะเขือเปราะ มะเขือเหลือง พริกชี้ฟ้า พริกขี้หนู และผักชีฝรั่ง (ได้รับการอนุญาตตั้งแต่วันที่ ๑๓ พฤษภาคม ๒๕๕๔) ถั่วฝักยาว คะน้า ผักกาดขาว ผักชี (ได้รับการอนุญาตตั้งแต่วันที่ ๙ กุมภาพันธ์ ๒๕๕๕) และเริ่มส่งออกตั้งแต่วันที่ ๒๖ พฤษภาคม ๒๕๕๕

Vegetables, fresh, chilled or frozen (food) — yard long beans (*Vigna sesquipedalis*) — aubergines — *Brassica* vegetables	0708 20 00; 0709 30 00; 0704;	Thailand	Organo-phosphorus pesticide residues	50

Why does fresh produce become the culprit ?

- Advances in agronomic, processing, preservation, packaging, shipping and marketing technologies enable to supply consumer a wide range of high-quality produce year round.

- The use of manure rather than chemical fertilizers, as well as the use of untreated sewage or irrigation water.

Why does fresh produce become the culprit ?

- Changes in the produce industry, social demographics, food consumption patterns and the awareness of fresh fruits and vegetables are potential vehicles of infection.

- The distribution of goods throughout the country.

- Increase of importation, knowledge of the presence and numbers of specific pathogens in imported produce.

- The contribution of epidemiology of disease.

Microorganism associated with produce-borne outbreaks

Listeria monocytogenes *Clostridium botulinum* *Bacillus cereus*	⇨	Naturally present in some soil, animal feces used as fertilizer, some packing type
Salmonella spp. *Escherichia coli* O157:H7	⇨	Inadequately decomposed manure, cross-contamination
Campylobacter jejuni *Vibrio cholerae*	⇨	Irrigation water containing untreated sewage, cross contamination
Parasites Viruses	⇨	Contaminated wash water, human handling

Source of contamination

Pre-harvest:

- Soil
- Irrigation water
- Inadequately composted manure
- Air (dust)
- Wild and domestic animals
- Human handling
- Water for other uses (apply fungicides, insecticides, growth hormone etc.)

Source of contamination (Cont.)

Post-harvest:

- Human handling (worker, consumers)
- Harvesting equipment
- Transport containers (field to packing sheds)
- Wild and domestic animals (including fowl and reptiles)
- Air (dust)
- Wash and rinse water
- Sorting, packing, cutting and further process equipment
- Ice
- Transport vehicles
- Improper storage
- Cross-contamination
- Improper display temperature
- Improper handling after wholesale or retail purchase
- Cooling water

Food Safety management in produce production in Thailand

Food Safety management consists of several steps and each step has to be controlled in order to produce the safe food for consumption.

These steps include from production or at farm level through table or consumer level, by using Good Agricultural Practice (GAP) as the criteria 7 issues as :

Good Agricultural Practice : GAP

1. Water reservior
2. Ground
3. Hazardous substances
4. Pesticides
5. Harvesting and post harvesting
6. Storage and handling
7. Recording

Good Agriculture Practices (USDA)

1. Soil and Water
2. Organic and inorganic fertilizers
3. Animal exclusion and pest control
4. Worker health and safety
5. Harvesting and cooling

GAP : 1. Soil and Water

- Identification of hazards associated with soil history
- Current or prior use of adjacent land
- Water resources and irrigation practices
- Potential produce contamination with water resource

Plan Before Planting

- Select site for produce based on land history and location.
- Use careful manure handling.
- Keep good records.

Ref. Food Safety Begins on the Farm A Grower's Guide


TPC:1.7x107
Coliform:6.6x104
E.coli:0 to 2x103
Salmonella < 3-30
TPC:2.9x10^4
Coliform:6.7x10^2
E.coli:0 to 1x10^2
Salmonella <3 -20

Field Management Considerations

- Optimize irrigation water quality and methods.
- Avoid manure side dressing.
- Practice good field sanitation.
- Exclude animals and wildlife.
- Emphasize worker training and hygiene.
- Keep records of above activities.

GAP : 2. Organic and Inorganic Fertilizers

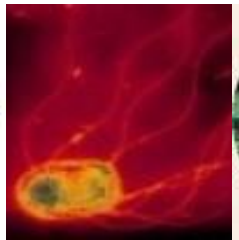
- Fertilizers – organic and inorganic
- Hazards associated with animal manure
- Composting
- Hazards associated with manure treatment and storage location
- Inorganic fertilization

Survival of Mixed Pathogens in Dried Animal Fertilizers

: *Salmonella* spp. and *Escherichia coli*





- ***S.* Hvittingfoss + *E. coli***
- ***S.* Augustenborg + *E. coli***

- **4 type of fertilizers**
- **(autoclaved) :**
  - **Bat**
  - **Hog**
  - **Cattle**
  - **Chicken**

25±2°C

40±2°C

Storage 0, 1, 3, 6, 9, 12, 15, 18 and 21 d

225 ml of 0.1% peptone water

25 g of fertilizer

Stomacher

10 ml

0.1 ml

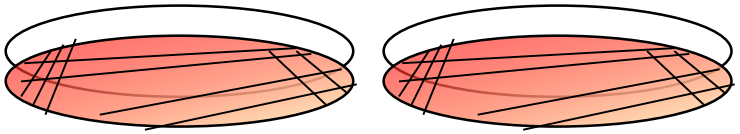
10 ml
2xTSB

Pre enrich
at 37 °C for 18 hrs

Salmonella spp.

E. coli

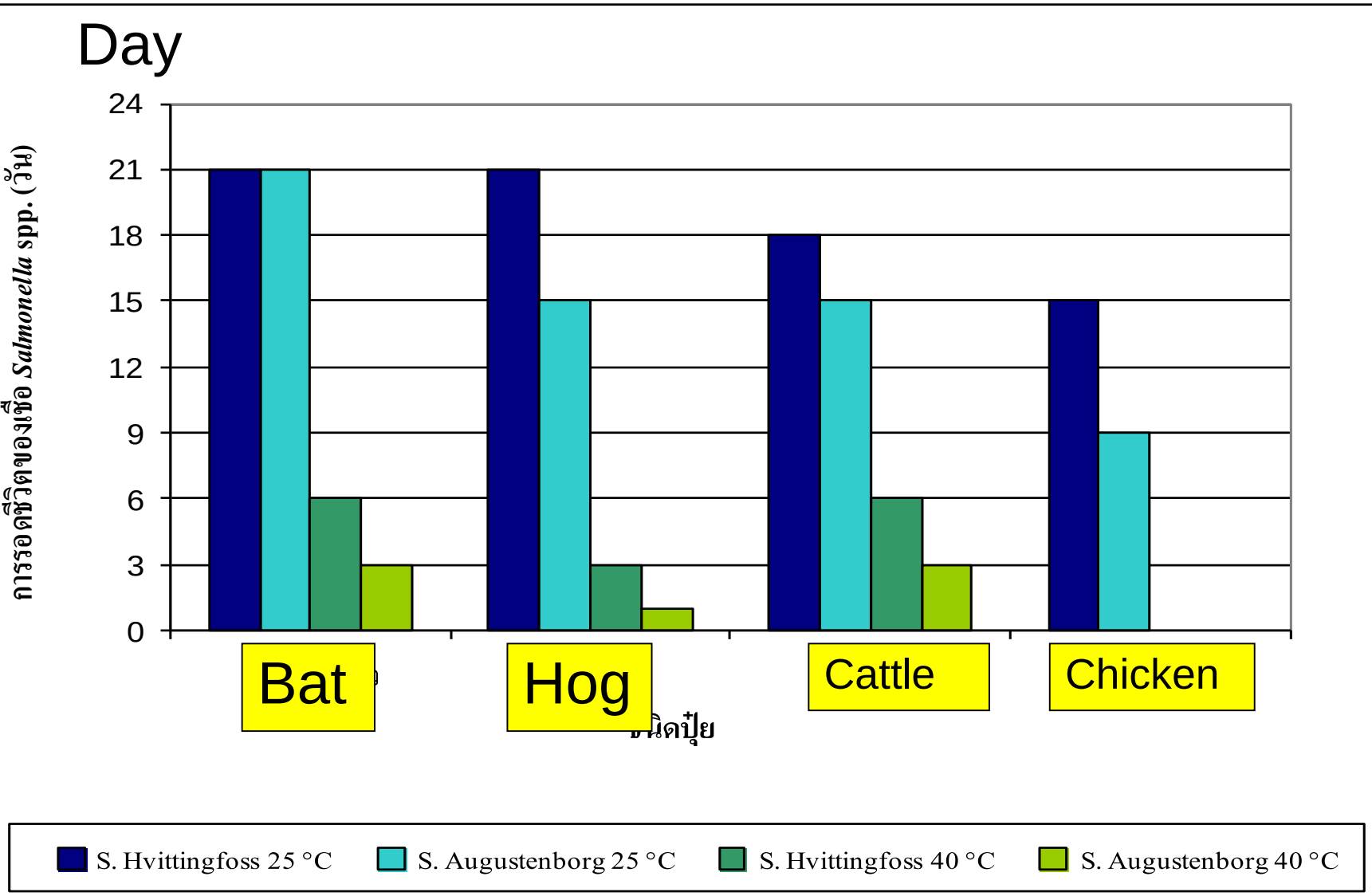
MacConkey agar



XLD agar

Incubate at 37 °C for 24 hrs

Incubate at 37 °C for 24 hrs



Survival of *S.* Augustenborg and *S.* Hvittingfoss in dried animal fetilizers during Storage at 25C and 40C

GAP : 3. Animal Exclusion and pest control

- Animal exclusion
- Keeping animals out of production areas
- Cleaning considerations for surrounding areas
- Animals and water
- Pest control in fresh produce operations
- Pesticides : Use and misuse

Wild birds are known to disseminate *Campylobacter*, *Salmonella*, *V. cholerae*, *Listeria* spp., *E. coli* O157:H7.

GAP : 4. Worker Health and safety

- Relationship between worker health and hygiene
- Health programs
- First – Aid Kit
- Drinking water
- Worker hygiene practices and sanitation facilities
- Hand washing

Post-harvest : Sources of Contamination

- Workers handling fruits and vegetables. Human and animals can shed foodborne pathogen in the absence of illness

- Training of new hired personnel to understand the significant of food hygiene. Hand washing all along the food chain is critical in reducing or eliminating contamination with fecal pathogens

- Emphasize food hygiene principle at high school or middle school levels

GAP : 5. Harvesting and cooling

- Safety hazards associated with harvesting
- Physical damage caused by mechanical harvesting methods
- Post – harvest water quality
- Cooling considerations : Hazards associated with cooling method

Harvest Considerations

- Clean and sanitize storage facilities and produce contact surface prior to harvest.
- Clean harvesting aids each day.
- Emphasize worker hygiene and training.
- Be sure to keep animals out of the fields and orchards.

Ref. Food Safety Begins on the Farm A Grower's Guide

Cross-Contamination on Fresh Produce During Washing Process

To investigate the possibility of cross-contamination during washing process in reused water with and without sodium hypochlorite

Using E. aerogenes as the Surrogate microorganisms

Cross contamination during washing vegetables with reused water and with/without sodium hypochlorite

Sequence of washing	Vegetables Samples	Sweet basil		Coriander	
		0 ppm NaOCl	50 ppm NaOCl	0 ppm NaOCl	50 ppm NaOCl
I	Washing inoc. veg	3.54 ± 0.28	2.92 ± 0.12	3.70 ± 0.52	3.18 ± 0.07
II	1st washing	2.23 ± 0.32	ND	2.31 ± 0.28	ND
III	2nd washing	2.27 ± 0.35	ND	2.25 ± 0.13	ND
IV	3rd washing	2.58 ± 0.25	ND	2.60 ± 0.18	ND

ND: not detected (Detection limit in vegetable 1 CFU/10g)

Microbial population found in reused water during washing with/without sodium hypochlorite

Sequence of washing	Water samples	Treatment			
		Sweet basil		Coriander	
		0 ppm NaOCl	50 ppm NaOCl	0 ppm NaOCl	50 ppm NaOCl
I	After washing inoc. veg	2.97 ± 0.10	ND	3.05 ± 0.05	ND
II	After 1st washing	3.01 ± 0.16	ND	3.05 ± 0.01	ND
III	After 2nd washing	3.01 ± 0.13	ND	3.03 ± 0.04	ND
IV	After 3rd washing u	3.02 ± 0.22	ND	3.05 ± 0.14	ND

ND: not detected (Detection limit in wash water 1 CFU/1 ml)

Good Manufacturing Practices

For Handling

Packing

Storage and

Transportation of

Fresh Produce

Good Manufacturing Practices : GMP

1. Building and premises
2. Equipment and machines
3. Process control
4. Sanitation
5. Maintenance and method of cleaning
6. Personal and hygiene

Besides GAP and GMP system many countries encourage to apply the Hazard Analysis and Critical Control Point : HACCP as additional system to prevent and control the problem of food safety

How to reduce of risk for human illness associated with raw produce

- Treatment of produce with sanitizer e.g. chlorinated water reduce populations of pathogenic and other microorganisms.

- ***But can not completely eliminate them !!!***

- Therefore, better control at points of potential contamination such

  - ***during harvesting***
  - ***during processing and distribution***
  - ***in retail markets, food service or preparation at home***

Post harvest Considerations

- Enforce good worker hygiene.
- Clean and sanitize packing area and lines daily.
- Maintain clean wash water.
- Cool produce quickly and maintain cold chain.
- Sanitize trucks before loading.
- Be sure to keep animals out of packing house and storage facilities.

Ref. Food Safety Begins on the Farm A Grower's Guide

Remove of pathogens

Chlorine

- Numerous sanitizing agents cab be used in sanitation program, but none has a broad spectrum of activity as chlorine.
- Chlorine is routinely used as sanitizer in wash, spray and flumes waters used in the fruit and vegetable industry.
- Antimicrobial activity depends on the free available chlorine (as hypochlorous acid).

Chlorine(Cont.)

- Total count were markedly reduce with increased conc. of Cl_2 up to 50 ppm, but a further increase in conc. up to 200 ppm did not have an additional substantial effect .

- A standard procedure for washing lettuce leaves in tap water was reported to remove 92.4% of the microflora while 100 ppm available free chlorine in water reduced the count by 97.8%.

Chlorine (Cont.)

- Barrier : microbial cell may harbor in crevices, pockets and natural opening in the skin.
- The hydrophobic nature of waxy cuticle on tissue surfaces protects surface contaminants from exposure to chlorine.
- Surface-active agents lessen the hydrophobicity of F&V skins, but may also cause deterioration of sensory qualities.

- ***Cleary, chlorine, at conc. currently permitted for use by the industry to wash fresh F&V can not be relied upon to eliminate pathogens.***

However, none of the chemical or physical treatments currently used to disinfect raw F&V can be relied on to eliminate all types of pathogen from the surface or internal tissues (without on adversely affect sensory or nutritional qualities).

Crop	Chlorine strength **	Ref.
General	50-500 ppm*	Food Safety Begins on the Farm A Grower's Guide
Asparagus	125-250 ppm	
Cantaloupe, Honeydew	100-150 ppm	
Lettuce, Cabbage, Leafy greens	100-150 ppm	
Tomatoes, Potatoes, Peppers	200-350 ppm	
Apples	100-150 ppm	

* ppm = parts per million

** Total titratable chlorine

Target (ppm)	ml/L	tsp/ 5 gal	cup/ 50 gal
Sodium Hypochlorite 5.25%			
50	0.95	3 + 2/3	3/4
75	1.43	5 + 1/2	1 + 1/10
100	1.90	7 + 1/4	1 + 1/2
125	2.40	9 + 1/10	1 + 7/8
150	2.90	10 + 7/8	2 +1/4
Sodium Hypochlorite 12.75%			
50	0.39	1 + 1/2	1/3
75	0.59	2 +1/4	1/2
100	0.78	3	3/5
125	0.98	3 + 3/4	4/5
150	2.90	4 + 1/2	9/10

Chlorine dioxide (ClO_2)

- ClO_2 is less affected by pH or organic matter and does not react with ammonia to from chloramines.

- But disadvantage of ClO_2 is that it is unstable.

- Must be generated on site and can be explosive when concentrated.

- An oxidizing power of ClO_2 is about 2.5 times of that of chlorine.

- The antimicrobial activity involve with the disruption of cell protein synthesis and membrane permeability control.

Efficacy of sanitizers to reduce mixed *E. coli* and *S.* typhimurium contaminated on babycorn and asparagus soaking for 15 min at 30 ± 2 C

Type of sanitizers	Conc. (ppm)		% Reduction	
			E. coli	*S.* typhimurium
Sodium chlorite	200	Babycorn	98.85	99.99
		Asparagus	98.22	99.98
Sodium chlorite +Tween 80,100 ppm	200	Babycorn	98.77	99.99
		Asparagus	82.22	99.97
Chlorine Dioxide	5	Babycorn	87.41	99.69
		Asparagus	NT	99.64

Source: Mahakarnchanakul *et al.*, 2001

Acids

- Some organic acids naturally found in or applied to F&V behave as fungistatics while other are more effective at inhibiting bacterial growth.

- The mode of action is attributed to direct pH reduction, depression of the internal pH of microbial cell, or disruption of substrate transportation by alteration of cell membrane permeability.

- Treat ready to use salads with 90 ppm PAA (peracetic acid) reduce total count and fecal coliforms by 100-fold similar to reduction with 100 ppm chlorine.

Acid (Cont.)

- The applying vinegar or lemon juice holds promise as a simple and inexpensive household disinfection procedure.

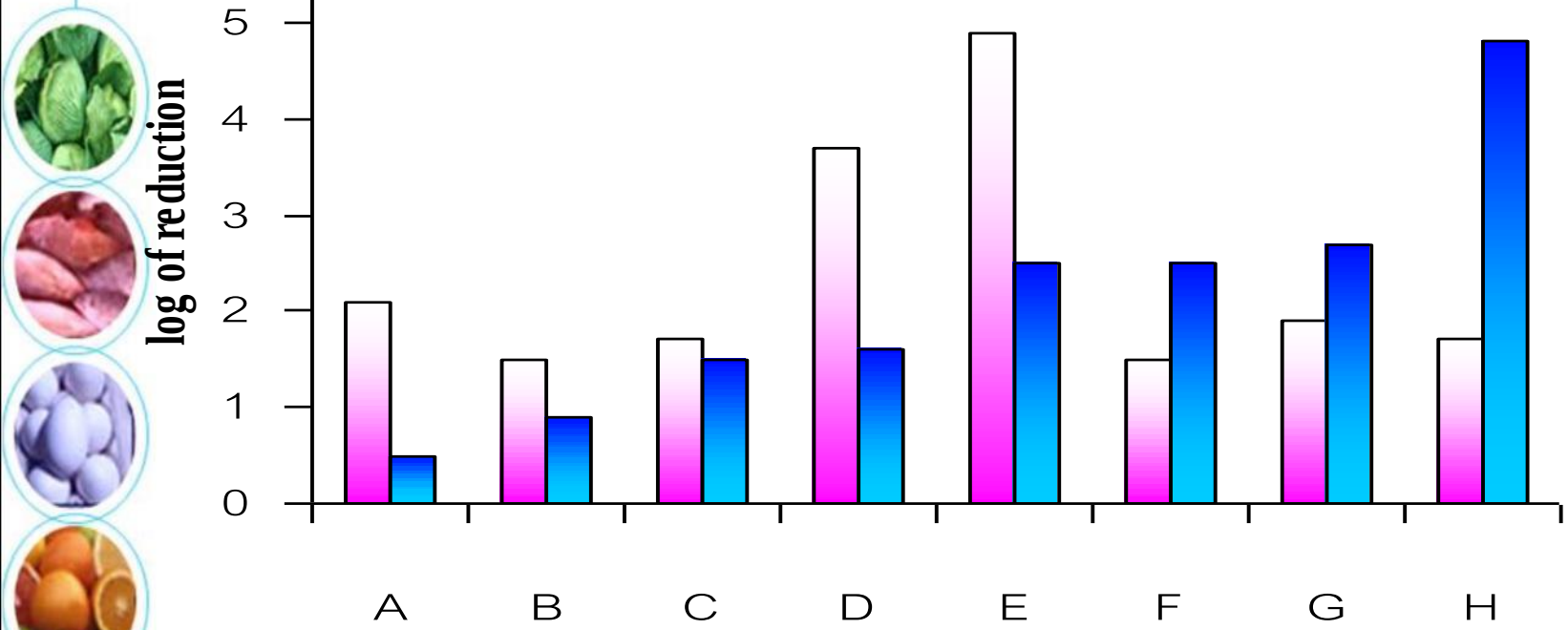
- A disadvantage is that these treatments may change the flavor and aroma of treated products.

Percent reduction of *E. coli* after treated with various sanitizers

Sanitizers	Conc. (ppm)	Time (min)	Percent reduction of *E. coli* (logCFU/ml)			
			Lettuce	Cabbage	Corriander	Mint
NaOCl	200	15	99.99	42.48	96.69	99.99
NaClO2	50	15	99.99	99.2	99.99	99.99
POAA	80	15	99.99	99.45	99.99	99.99

Source : Mahakarnchanakul and Vibulsresth, 2000

Effectiveness of various sanitizers to reduce *E. coli* and *S.* Typhimurium on lettuce after washing for 15 min at 30+2°C



A	Sodium bicarbonate	0.9 g/ L	E	Sodium hypochlorite	200 ppm
B	Lauryl	2 ml/L	F	Potassium permanganate ($KmnO_4$)	0.25 %
C	Fit	5%	G	Vinegar	1%
D	Sodium chlorite	50 ppm	H	Peroxyacetic acid	40 %

Hydrogen peroxide (H_2O_2)

- A lethal or inhibitory effect on microorganism, depending on the pH, temperature and other environmental factors.

- H_2O_2 vapor treatments were highly effective in reducing microbial number on whole cantaloupes, grapes, prunes, raisins, walnuts and pistachios.

- But inducing browning in mushrooms and shredded lettuce.

- Exposure to H_2O_2 vapor caused bleaching of anthocyanins in strawberries and rasberries.

Ozone (O_3)

- *S.* Typhimurium, *Y. enterocolytica*, *S. aureus* and *L. monocytogenes* are the pathogens sensitive to treatment in ozonated (20 ppm) water.

- Enteric viruses and oocysts of protozoa such as *Cryptosporidium pavum* are also sensitive to ozone.

- The lethal effect of ozone is its strong oxidizing power.

- Because of its instability, ozone must be generated at the usage site.

Ozone (Cont.)

- Metal and other types of surfaces may be aware when come to contact with ozone.

- The use of ozonated water and flume-waters in F&V handling and processing operations provides a method to control build-up of microbial number, particularly in recycled water.

Natural flora found in some fresh vegetables

Typed of vegetable	Total aerobic count (log CFU/ml)
White cabbage (n = 10)	4.6-4.8
Mint (n = 10)	4.9-5.8
Coriander (n = 20)	4.1-5.5
Green shallot (n = 12)	4.6-5.3
Baby corn (n = 20)	4.9-6.3
Asparagus (n = 20)	4.9-6.5
Lettuce (n = 48)	4.3-4.5

Source : Mahakarnchanakul and Vibulsresth, 2000

•Several pathogenic bacteria, viruses and parasites capable of causing human illness disease can be found on raw F&V .

•Some are capable of growing on whole, minimally processed or cut F&V under handling and storage conditions.

•It is essential to prevent contamination of raw F&V and remove disease-causing microorganism prior to consumption by using the appropriate interventions.

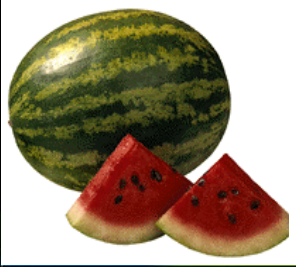
However, none of the chemical or physical treatments currently used to disinfect raw F&V can be relied on to eliminate all types of pathogen from the surface or internal tissues (without on adversely affect sensory or nutritional qualities).

Food safety management for fresh produce

- Food safety issues in fresh and fresh cut produce
- Food safety management in produce production in Thailand
- Microbial hazards
  - Remove of pathogens using various sanitizers
- **Chemical hazards**
  - **Remove of pesticides using oxidizing agents**

Food Safety and Quality Management

- Good Agricultural Practice
- Good Manufacturing Practice (at packing house)
- Hazard Analysis Critical Control Points
- Hygienic Practices (at retail sale)
- Risk communication






Interested Reference to Read

U.S. Dept. of Health and Human Services, FDA . Center for Food and Applied Nutrition (CFSAN) 1998. *Guidance for Industry: Guide to Minimize Microbial Food Safety Hazards for Fresh Fruit and Vegetables*. Oct. 1998. http://www.fda.gov.

FDA. Analysis and Evaluation of Preventive Control Measures for the Control and Reduction/Elimination of Microbial Hazards on Fresh and Fresh-cut Produce. *Chapter IV and Chapter V.* http://www.fda.gov.

Rangrajan A. *et al*. *Food Safety Begins on the Farm. A Grower's Guide.* Good Agricultural Practices for Fresh Fruits and Vegetables.

Thank you