Department of Primary Industries

# Melon food safety toolbox

## Practical resources for implementing best practice

FIRST EDITION 2019

Dr Sukhvinder Pal (SP) Singh

www.dpi.nsw.gov.au

Melon food safety toolbox: practical resources for implementing best practice

Contributors from NSW DPI:

- Zabrina Khan, Technical Assistant
- Dr Amanda Warren-Smith, Development Officer

### Cover images

Large photo: netted skin of a rockmelon fruit (SP Singh, NSW DPI)

Small photos in circles (from bottom left to top right):

- Andrew Creek recording data in a packhouse
- A worker washing harvest bins in a melon farm at Griffith, NSW
- An automated chlorine monitoring and datalogging system
- A multi-parameter probe measuring the pH, temperature and oxidation-reduction potential (ORP) of wash water
- An oxidation-reduction potential (ORP) probe in a wash water solution.



Published by NSW Department of Primary Industries, a part of NSW Department of Industry.



First published June 2019

ISBN Print: 978-1-76058-337-8

ISBN Web: 978-1-76058-336-1

Job No. 15181



### Always read the label

Users of agricultural chemical products must always read the label and any permit before using the product and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from any compliance with the directions on the label or the conditions of the permit by reason of any statement made or omitted to be made in this publication.

**Funding**

This project has been funded by Hort Innovation, using the melon research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

**Acknowledgements**

This melon food safety toolbox has been produced as part of the Food Safety Training, Extension and Capacity for the Melon Industry Project (VM17002) funded by Hort Innovation using the melon industry levy, co-investment from NSW DPI and funds from the Australian Government. Greatest appreciation is expressed to the melon growers and packers who allowed photography at their properties and facilities for developing this resource. Zabrina Khan is thanked for her excellent design work in producing this toolbox. All members of the Horticultural Food Safety Research Group and staff of NSW DPI who contributed to this toolbox are thanked for their valuable inputs and suggestions.

NSW GOVERNMENT | Department of Primary Industries

# Melon food safety toolbox

## Practical resources for implementing best practice

**Dr Sukhvinder Pal (SP) Singh**

Research Horticulturist (Food Safety)

NSW Department of Primary Industries | Agriculture

The University Campus | North Loop Road | Ourimbah | NSW 2258

Mail: Locked Bag 26 | Gosford | NSW 2250

T: 02 4348 1935 | M: 0420 593 129 | E: sp.singh@dpi.nsw.gov.au

Hort Innovation Strategic levy investment | MELON FUND

This project has been funded by Hort Innovation using the melon research and development levy and funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au

# Contents

# Mitigating food safety risks to consumers and industry

# FRUIT WASHING & SANITISING

## Critical Control Parameters

Use potable/drinking water containing a **sanitiser** for washing the fruit.

Sanitiser must be **effective** and at an appropriate **concentration**.

Regularly maintain, **monitor and record** the sanitiser concentration.

Maintain, monitor and record fruit's **contact time** with sanitised water.

Monitor and adjust pH if chlorine is used as a sanitiser.

Monitor and record water and fruit flesh temperature.

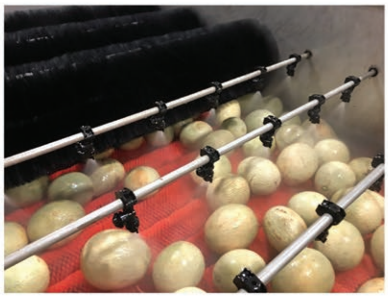
Sanitised water spray must cover all fruit and brushes.

Distribute nozzles for uniform washing across all rollers and brushes.

Maintain uniform wash water flow and pressure.

Brush rollers must be kept clean and debris-free.





# DUMP TANK MANAGEMENT

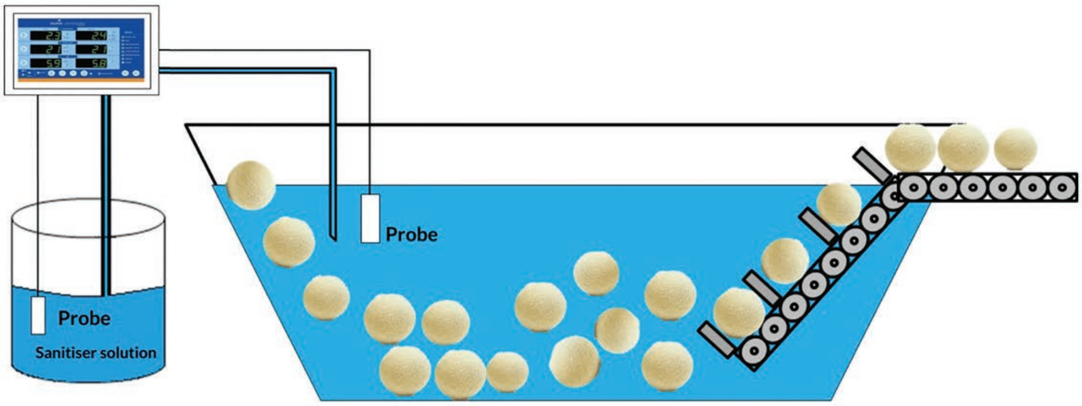
## Critical Control Parameters

Use potable/drinking water containing a **sanitiser** in dump tank.

Maintain and monitor appropriate sanitiser concentration.

Automate injection and monitoring of sanitiser and use an alarm system.

Keep the fruit's holding time in the dump tank to a minimum.




Monitor and adjust pH if chlorine is used as a sanitiser.

Monitor, record and adjust water temperature.

Determine water replacement frequency based on organic load of fruit.

Monitor and manage organic load by measuring turbidity.

# VALIDATION OF FRUIT WASHING & SANITISING PROCESSES

Washing and sanitising are critical postharvest operations for rockmelons to reduce the microbial load on the fruit surface through high pressure washing and brushing with water containing an effective sanitiser, as well as to remove organic matter or debris from the fruit surface. The validation of this process is critical in demonstrating that the design of your washing and sanitising system can adequately control identified hazards to produce a safe product. Simply put, validation is demonstrating that your process is capable of accomplishing what you expect it to do.

## 1 Identify the potential target pathogens.

Examples:
- *Salmonella species*
- *Listeria monocytogenes*
- Pathogenic *E. coli*

## 2 Set the performance standards.

Examples:
- No detection of foodborne pathogens on the fruit
- Minimum 2-log (99%) reduction of total plate count on the fruit surface
- No physical damage or chemical burn on the fruit

## 3 Define and outline all factors affecting the process.

Examples:
- Water quality, pressure and flow rate of wash water
- Sanitiser concentration (C) x contact time (T)
- Brushing (overhead and flat bed), organic load on the fruit

## 4 Outline operational limits of each factor.

Examples:
- Minimum & maximum sanitiser level (e.g. 100-200 ppm free chlorine)
- Minimum and maximum contact time (e.g. 1 - 2 min)
- C x T values (e.g. 200 for chlorine)

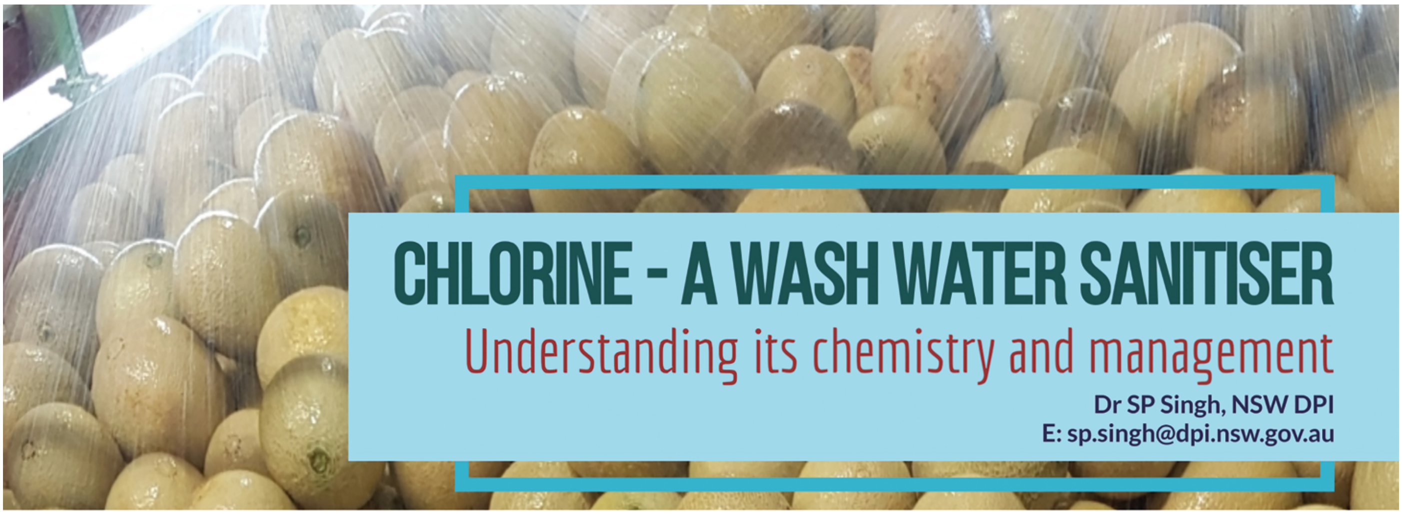
## 5 Determine fixed and variable factors affecting the process efficacy.

- Fixed: water source and treatment system, washing equipment (e.g. brushes, spray bar), sanitiser type (e.g. chlorine, peracetic acid), contact time (e.g. produce feed rate), sanitiser monitoring system & produce type
- Variable: sanitiser concentration, organic load and water pH

## 6 Validate the variable conditions.

*Validation options:
- Maintain minimum effective sanitiser concentration in each washing & sanitising run including worst-case conditions
- Inoculate fruit with a surrogate pathogen to demonstrate process efficacy

*More details of each of these options can be found in the Best Practice Guide



# CHLORINE - A WASH WATER SANITISER

## Understanding its chemistry and management

**Dr SP Singh, NSW DPI**
**E: sp.singh@dpi.nsw.gov.au**

Chlorine is one of the most widely used sanitisers due to its low cost and easy availability. In the melon industry, two forms of chlorine are commonly used- sodium hypochlorite (liquid) and calcium hypochlorite (powder).

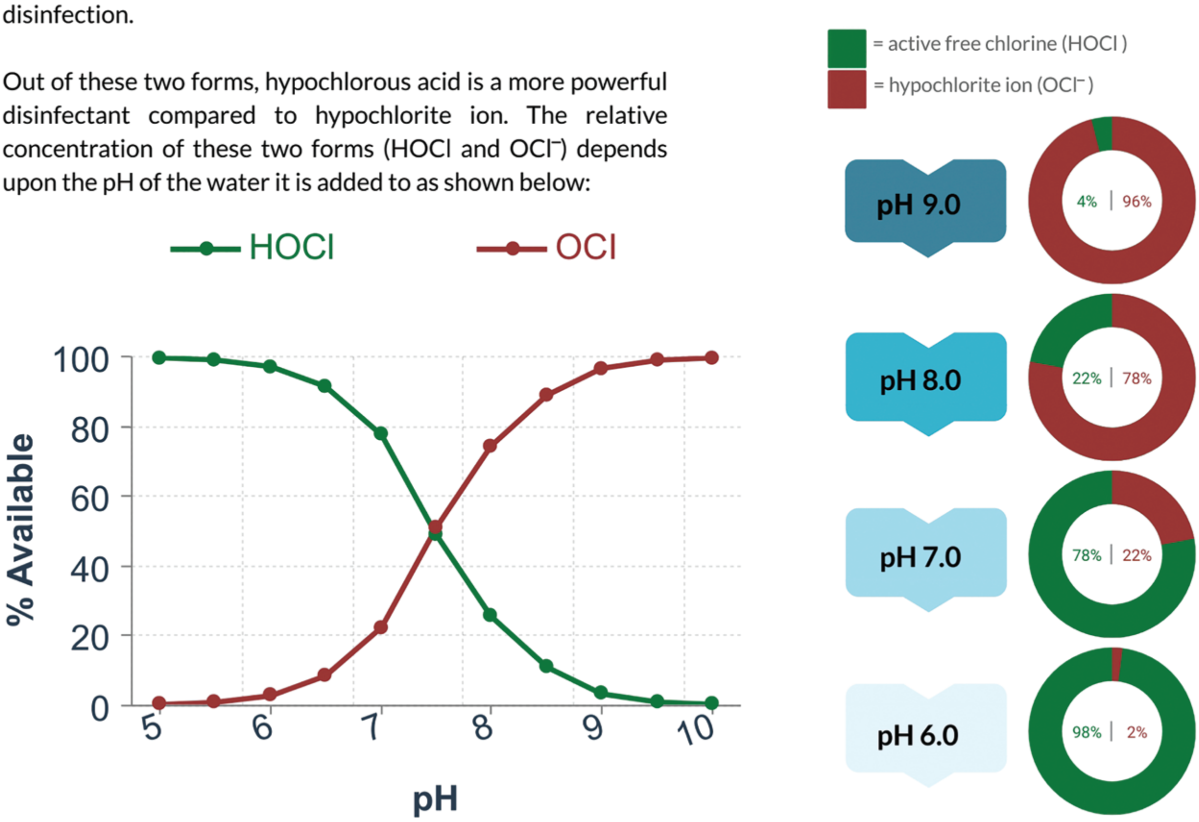
When sodium or calcium hypochlorite is dissolved in water, the hypochlorite will take on two forms- hypochlorous acid (HOCl) and hypochlorite ion ($OCl^-$). The combined concentrations of hypochlorous acid and hypochlorite ion represent the amount of 'Free Chlorine' available for disinfection.

Out of these two forms, hypochlorous acid is a more powerful disinfectant compared to hypochlorite ion. The relative concentration of these two forms (HOCl and $OCl^-$) depends upon the pH of the water it is added to as shown below:

At pH lower than 7.0, the hypochlorous acid predominates. When the pH increases above 7.0, the concentration of hypochlorite ions increases.

When pH is maintained between 6.5-7.0, hypochlorous acid is present in higher concentrations. For most effective disinfection, ensure the pH of the chlorinated water is 6.5-7.0.

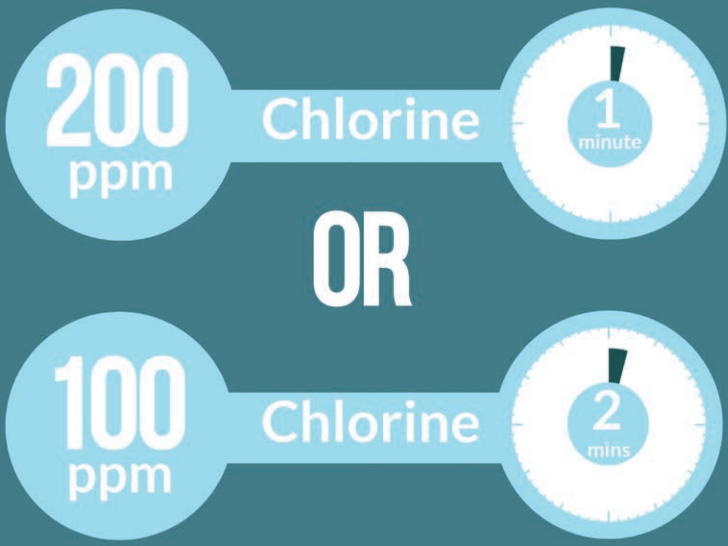
### Chlorine is most effective at pH 6.5 -7.0




**Relative proportions of hypochlorous acid and hypochlorite ion as influenced by the pH**

# FACTORS AFFECTING THE EFFICACY OF CHLORINE

The effectiveness of chlorine is broadly a function of its concentration, contact time, pH, organic matter and temperature.




Some common terminologies associated with chlorine that you should be familiar with:

**Free chlorine** or available chlorine is the amount of chlorine in the form of hypochlorous acid, hypochlorite ion and chlorine gas.

**Combined chlorine** is the amount of chlorine that has reacted with nitrogen-containing compounds (e.g. ammonia) in water to form chloramines that are not effective in sanitisation.

**Total chlorine** is the sum of free or available and combined chlorine.

**Chlorine demand** is the difference between the amount of chlorine added to water and the amount of free chlorine or combined chlorine remaining at the end of a specified time period.


## Concentration

The recommended free chlorine concentration in the wash water for postharvest sanitisation of rockmelons is 200 ppm (Materon, 2003; Rodgers et al., 2004; Parnell et al., 2005). Some research studies on the efficacy of chlorine against foodborne pathogens have reported longer contact times (5 to 10 min) which are not feasible to achieve under commercial conditions. Based on the current information in the literature, it is recommended that rockmelons and specialty melons may be washed with chlorinated water containing 200 ppm free chlorine with an exposure time of 1 min or 100 ppm of free chlorine for 2 minutes at 6.5-7.0 pH.

As explained above in the basic chemistry of chlorine, it is critical to maintain the pH of chlorinated water at neutral (7.0) to achieve effective sanitisation through the abundance of active form (hypochlorous acid) of chlorine. However, the concentration of chlorine should not be considered the only parameter of effective sanitisation, other factors such as the contact time and pH are equally important.

Free chlorine measurements don't distinguish between two forms of hypochlorites (HOCl and OCl-) that are present in water. That is why it is important to measure the pH to determine the active free chlorine. For example, 100 ppm of free chlorine at pH of 9 has only 4% of hypochlorous acid, with 96% being hypochlorite ion. The same amount of free chlorine at a lower pH of 6.0 will contain 98% of hypochlorous acid and 2% hypochlorite ion, dramatically increasing the disinfection power of the same wash water solution at a lower pH.

The data on chlorine concentration of the wash water or dump tank must be recorded along with the pH of the same water sample. The chlorine concentration records without pH values should not be accepted for validation and verification of food safety plans in a melon packing house.

# FACTORS AFFECTING THE EFFICACY OF CHLORINE

The effectiveness of chlorine is broadly a function of its concentration, pH, contact time, organic matter and temperature.

## Contact time

Total contact time of fruit with the chlorinated water influences the ability of active chlorine (hypochlorous acid) to kill or inactivate microbial pathogens. A minimum contact time of 2 minutes is required to achieve the desired sanitisation when the concentration of free chlorine are at appropriate levels (100 ppm). But do consider other factors such as organic load on the incoming fruit, efficacy of pre-rinse/wash step, brushing and high pressure washing etc. Determine the contact time for your packing operation based on the validation and verification of your washing and sanitising procedure.

## pH

The pH is a critical factor which determines the effectiveness of chlorine as a sanitiser. The pH scale ranges from 0-14. The pH value 7 is neutral, less than 7 is acidic and more than 7 is alkaline. The addition of chlorine both in liquid and solid forms increases the pH of the water it is added to. If the water is acidic (pH 6 to 7), a minor increase in the pH due to the addition of chlorine may not have a major impact on the efficacy. However, if the water is neutral (pH 7) or alkaline (pH greater than 7); the pH of solution after addition of chlorine will increase towards alkaline conditions, rendering the chlorine ineffective due to a lower concentration of the active form, hypochlorous acid.

As such, the pH of wash water must be monitored after the chlorine solution is added, then adjusted to between 6 and 7 using food grade organic or inorganic acids such as hydrochloric acid and citric acid. If the pH is not properly adjusted, the chlorine solution will not be effective in sanitising the produce. If the pH of the chlorinated water is outside the acceptable range (6.5-7.0), it is highly corrosive to equipment (pH $<6.0$), forms chlorine gas (pH $<5.0$) that releases fumes irritating skin and eyes or is much less effective as a sanitiser (pH $>8.0$).

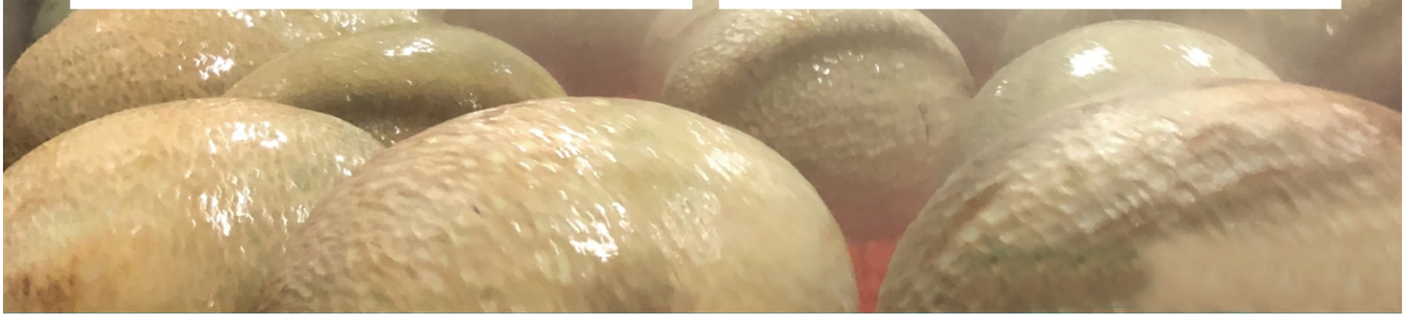
## Organic matter

Organic matter, soil and debris present on the fruit surface or in the water react with free chlorine. The presence of soil on the fruit surface interferes with the ability of chlorinated water to achieve sanitisation. Pre-washing/rinsing fruit with potable water is therefore a good practice to minimise the organic matter on the fruit before it enters the washing and sanitising zone. The clean surface of prewashed fruit gets sufficient contact time with the chlorinated water, thus reducing the microbial load on the fruit surface to safe levels. The higher the organic load present on the fruit surface or in the water, the higher the chlorine demand. Turbidity measurement should be used an objective measure of the cloudiness or organic load in the water.

In re-circulatory washing systems and dump tanks, the calculation of chlorine demand is more pertinent to achieve an effective sanitisation. Under some circumstances (heavy rainfall, dust storms), the organic load may be very high on the incoming fruit. The decision on the water replacement frequency should be thus made based on the ability of current sanitiser levels to compensate for chlorine demand. The fixed water replacement frequency (e.g. twice a day) is not a good practice considering variation in the organic load on the incoming fruit depending upon fruit type (honeydew versus rockmelon), cultural practices and weather events.

## Temperature

Water temperature should be continuously monitored and recorded to prevent infiltration of water into the porous skin of rockmelons. Ensure the fruit pulp temperature is lower than the wash water temperature. Heating of chlorinated water can cause the escape of active chlorine.



# HOW TO CALCULATE VOLUME/WEIGHT OF SODIUM/CALCIUM HYPOCHLORITE REQUIRED TO OBTAIN A SPECIFIC CONCENTRATION

Depending on what chlorine products are used will determine how much of that chemical will be needed to achieve the desired concentration (ppm). Ensure to consult the label of the product and see the percentage of active ingredient to determine the concentration of the starting material. If the chlorine source is in the solid powder form, it contains a different concentration of chlorine in it e.g., calcium hypochlorite power contains 30-35% w/w of chlorine, calcium hypochlorite granules contain 65-70% w/w of chlorine. If the chlorine source is in the liquid form e.g., sodium hypochlorite, it contains a relatively low amount of chlorine (14-16% w/v). Knowing this concentration is essential for calculating how much you will need to get the desired concentration of chlorine in the wash water or dump tank.

By knowing the desired target concentration, the volume of the tank size being used and the concentration of the initial chlorine product, the amount needed of the initial chlorine product can be determined using this formula.

$$\text{Volume to add} = \frac{(\text{Target ppm of free chlorine})\text{x (total tank volume)}}{(\%\ \text{NaOCl in source})\text{x } 10{,}000}$$

For example, if you need to prepare 100 litres of a 150 ppm solution from a 10.0% sodium hypochlorite (NaOCl), you can use the above formula or the following equation:

$$\text{Volume to add} = \frac{(150\text{ ppm})\text{x } (100\text{ L})}{(10\text{ NaOCl})\text{x } 10{,}000\text{ ppm}} = 0.15\text{L or } 150\text{ ml}$$

Final steps:

- Adding 150 ml of 10.0% sodium hypochlorite solution to a 100 litre tank of potable water will get you to the required 150 ppm concentration for your solution.
- Measure the pH of the chlorinated water and adjust it between 6.5 -7.0 either by lowering the pH (addition of an acid, e.g. citric acid) or raising the pH as required.
- Measure the concentration of free chlorine using a high range digital photometer.

# MEASUREMENT AND MONITORING OF CHLORINE

Once chlorine concentration has been determined and an appropriate amount added or injected to the wash water system or dump tank, a determination of the free chlorine concentration (parts per million) should be done. There are several methods of measuring the free chlorine in the water.

Photometers generally provide the highest accuracy and precision for measuring free chlorine in water. Using the standard DPD method of measuring free chlorine, a chemical reagent called DPD (N,N-Diethylparaphenylenediamine) is added to the water sample containing free chlorine. DPD reacts instantly to produce a pink hue in the presence of chlorine, with higher concentrations producing a deeper colour. This colour change is then measured by the photometer.



## Sensors

Chlorine sensors make use of chronoamperometry and electrochemistry in order to measure electrical currents generated by chemical reactions. They apply a set voltage to an electrode and record the electrical currents over time (approximately 1 min). The magnitude of the current is proportional to the concentration of chlorine in the sample. These sensors are disposable and single use that require no additional reagents or glassware. Readings are also no affected by colour of sample or turbidity.

## ORP meters

An oxidation-reduction potential (ORP) probe can be used to measure oxidising potential of the wash water and provide indirect measurement of the effectiveness of chlorine as a sanitiser. The ORP value of wash water has a direct correlation to required contact time to destroy or inactivate harmful bacteria. Since ORP can be measured rapidly both in-line and off-line, ORP (at least 650 mV) is a convenient parameter for determining effectiveness of the wash water.

## Test strips

Readily available and easy to use, chlorine test strips are able to measure free chlorine in a number of different ranges of concentrations. However they are unreliable and subject to variation amongst different users. They are not recommended to be used to monitor chlorine concentrations for food safety records.

Other products are commercially available in the market that aim at measuring chlorine concentrations both free and total. These include titration kits that measure the colour change using drops of reagent to a sample and colourimetric methods that use reagents such as DPD to add to samples and compare colour of sample to colour comparators.

# AUTOMATION OF DOSING AND MONITORING OF CHLORINE

Automated dosing and monitoring systems are highly recommended for sanitiser control in the wash water used in packhouses. Verification of automated dosing and monitoring systems must be carried out using digital tools mentioned in the previous sections.


There are a number of advantages of automation such as:

- Elimination of human error and variability.
- Maintenance of consistent levels of sanitiser concentration and effectiveness.
- Continuous monitoring and precise control over the set levels of sanitiser (chlorine) and pH balance.
- Automatic logging of data for electronic record-keeping.

**Note: Verification of automated dosing and monitoring systems must be carried out using digital tools mentioned in the previous sections.**

# PERACETIC ACID- A WASH WATER SANITISER

## Understanding its chemistry and management

**Dr SP Singh, NSW DPI**
**E: sp.singh@dpi.nsw.gov.au**

Peracetic acid, peroxyacetic acid, or PAA is an equilibrium mixture of peroxy compounds, hydrogen peroxide and acetic acid. Once dissolved in water, it breaks down into carbon dioxide, oxygen and water. It is an effective sanitiser which functions as a strong oxidising compound and is appropriate for the washing and sanitising of rockmelons and specialty melons.

The Australian Pesticides and Veterinary Medicines Authority (APVMA) label recommendations for PAA use is at a concentration of 80 ppm for 45 seconds. To minimise the microbial food safety risks, research has shown that increasing contact time with PAA enhances killing of foodborne bacterial pathogens on the fruit surface (Rodgers et al., 2004; Singh et al., 2018). PAA has been shown to be more effective against *L. monocytogenes* than other sanitisers such as chlorine (Singh et al., 2018).

***For washing and sanitising rockmelons and specialty melons, 80 ppm concentration of PAA is recommended with a minimum 2 minutes contact time. PAA is recommended to be used as a cross contamination control in dump tanks at 100 ppm.***

# FACTORS AFFECTING THE EFFICACY OF PAA

- PAA efficacy increases with the increase in concentration and contact time.
- The efficiency of PAA is not influenced by organic matter in wash water, but is affected by the pH and temperature of the water.
- Most effective at neutral pH (7), the efficacy reduces as pH increases.
- Functions extremely well under cold conditions (4°C).
- Less impacted by organic matter and soil than chlorine solutions (Artés-Hernández et al. 2007).
- Environmentally friendly and do not produce any harmful by-products.
- PAA decomposition is influenced by temperature and should be stored in a temperature controlled environment (<25°C). It should be kept away from direct sunlight.
- PAA rapidly decomposes at high temperatures (over 45°C), effectively reducing its efficacy if not replenished (Kunigk et al., 2001).
- High concentrations of PAA (>100ppm) can affect the quality of produce due to its strong oxidising power.

*Merits*

- Is a strong oxidant and disinfectant
- Is environmentally friendly
- Does not produce any harmful by products
- Is less corrosive to equipment than hypochlorites
- Has a broad range of efficacy
- Has good biofilm penetration compared to hypochlorites
- Is also very good on moulds and spores

*Demerits*

- Corrosive to soft metal and skin
- Produces strong pungent odour from both concentrate and diluted forms
- Breaks down quickly once diluted with water, needs to be used quickly
- Varied activity against fungi
- Prolonged exposure may cause product damage
- More expensive than chlorine and some other sanitisers

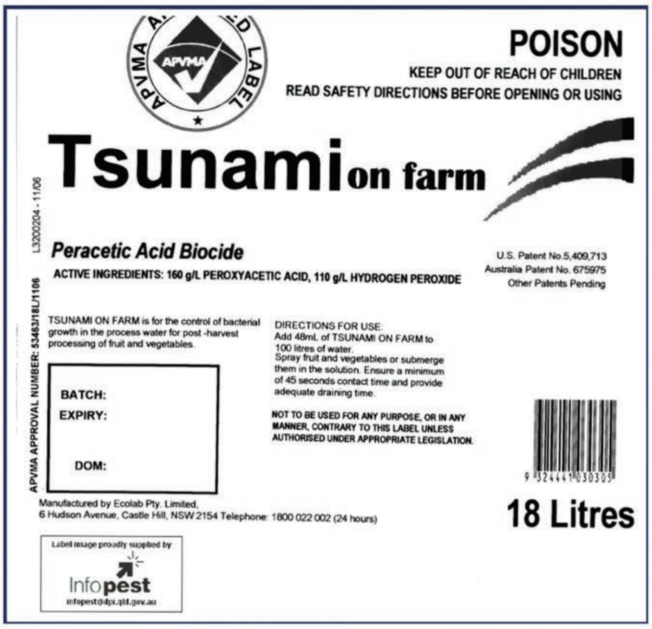
# HOW TO CALCULATE VOLUME AND SPECIFIC CONCENTRATION OF PERACETIC ACID MIXTURE

Depending on what peracetic acid products are used will determine how much of that chemical will be needed to achieve the desired concentration (ppm). Consulting the label of the product is essential to identify the concentrations of active constituents in the starting PAA mixture. Concentrations of peracetic acid and hydrogen peroxide vary from brand to brand.

| Trade Name | Brand Name | Peracetic Acid (PAA) | Hydrogen Peroxide ($H_2O_2$) |
|---|---|---|---|
| Tsunami on Farm | Ecolab | 16.0% | 11.0% |
| Tidal Surge | Easyclean | 16.0% | 11.0% |
| Perasan | Castle Chemicals | 15.7% | 6.0% |
| Adoxysan Peracetic Acid Biocide | Advance Chemicals | 16.0% | 11.0% |
| Pinnacle-Peracetic Acid Biocide | Sopura | 16.0% | 11.0% |

Source: www.infopestguide.com.au

For example, consider the label below:




**Active constituents are labelled as:**
160 g/L (16%) Peroxyacetic Acid and
110 g/L (11%) Hydrogen peroxide

**Directions of use:** Add 48 ml of Tsunami on Farm to 100 litres of water. Ensure a minimum of 45 seconds contact time.

We want to ensure that the recommended **60-80 ppm of the active constituent, peroxyacetic acid** is achieved.

Note: 1% is equivalent to 10 000 ppm.

To **find the volume needed** to obtain a specific concentration in a known volume size, use equation below.

$$\text{Volume to add} = \frac{(\text{Target ppm of PAA})\text{x}\,(\text{total tank volume})}{(\%\text{ of PAA in starting mixture})\text{x}\ 10{,}000\ \text{ppm}}$$

$$\text{Volume to add} = \frac{(80\ \text{ppm})x\ (100L)}{(16\ \%\ PAA)\ x\ 10{,}000\ \text{ppm}} = 0.050\text{L or }50\text{ml}$$

To **find the specific concentration of PAA** when following instructions from product label, use equation below.

$$\text{ppm of PAA} = \frac{\text{Volume added x }(\%\text{ of PAA})\text{x }10\,000\text{ppm}}{\text{Total tank volume}}$$

$$\text{ppm of PAA} = \frac{0.048\text{ x }(16)\text{x }10\,000\text{ppm}}{100} = 76.8\text{ ppm}$$

**Preparing the PAA solution:**

- Add 48 ml of Tsunami on Farm to 100 L of water to achieve 76.8 ppm of peracetic acid.
- To achieve 80 ppm, 50 ml of Tsunami on Farm needs to be added to 100 L of water.

# MEASUREMENT AND MONITORING OF PAA

It is important to strictly monitor the levels of PAA in postharvest washing operations.at regular intervals (e.g. every 30 min ). Continuous monitoring through inline feedback sensors and automated injection systems will be advantageous for large packing operations. Specific sensors designed to accurately measure concentrations of PAA should be used if an automated system is preferred.

## *Sensors*

PAA sensors make use of amperometry and electrochemistry to measure electrical currents generated by chemical reactions. An electrode is placed in a sample that interacts the PAA within the sample, creating a current. The magnitude of the current is proportional to the concentration of PAA in the sample. Sensors measure PAA without cross-sensitivity towards hydrogen peroxide. Readings are also not affected by the colour of sample or turbidity.


## *Test strips*

Digital methods of measuring PAA should be preferred over test strips. Test strips are quick and easy to use but do not offer high levels of accuracy. Test strips involve dipping strips in samples containing PAA. Pads on the strip change colour according to the concentration. These colours are then compared to a printed colour chart provided which is specifically designed to represent colour reactions at various concentrations.

## *Titration kits*

Colourimetric titration offers a fast, economical and fairly accurate method. This method relies on the ability of PAA to oxidise a titrant. There are three titrimetric methods commercially available: permanganate, ceric sulfate and iodometric. All three have similarities, but the iodometric method is seen as the most rapid and direct method of PAA measurement. Iodide is oxidised by PAA to iodine which reacts with starch resulting in dark purple black colour. This PAA solution is then titrated with sodium thiosulfate to reach a colourless endpoint. The number of drops of sodium thiosulfate needed to reach this endpoint determines an approximate concentration of PAA in the solution.


# POTENTIAL HOT SPOTS FOR CROSS-CONTAMINATION OF MELONS

## CLEAN & SANITISE

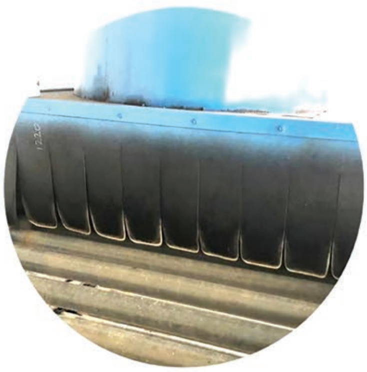
### HARVEST BINS

### DUMP TANKS

### REUSED WATER

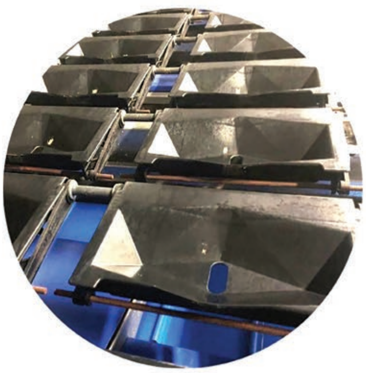
### BRUSHES

### CURTAINS



### CONVEYORS

### GRADING CUPS



### PACKING TABLES

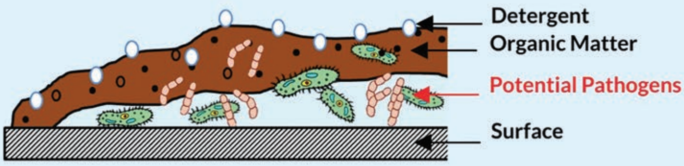
### COOL ROOMS

# Packhouse cleaning & sanitising

- Cleaning and sanitising are two distinct processes to achieve pathogen control in packhouse environments.
- Cleaning is the complete removal of soil, debris and food particles using detergents under recommended conditions. A surface must be cleaned before it can be sanitised.
- Sanitising is the substantial reduction in the number of microorganisms using chemical sanitisers with appropriate concentrations and contact times.
- Develop and follow sanitation standard operation procedures for fruit contact (e.g. harvest bins, conveyors) and non-fruit contact surfaces (e.g. walls, floors). Wear appropriate personal protective equipment (e.g. gloves, footwear, safety glasses).
- Food grade detergents and sanitisers should be used for fruit contact surfaces. Avoid high pressure washing to prevent spreading of contaminants through aerosol formation.

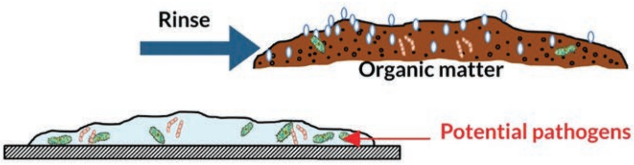
## 1. Clean

Pre-rinse target surface with water to loosen and remove soil and debris. Apply detergent and scrub the surface properly. Mechanical force, concentration, time and temperature are four factors influencing cleaning efficacy.




## 2. Rinse & Inspect

Perform a post-rinse step to remove detergent and remaining soil and debris loosened by washing. Rinse equipment and other surfaces from top to bottom. Conduct a visual inspection to assess effectiveness of cleaning.

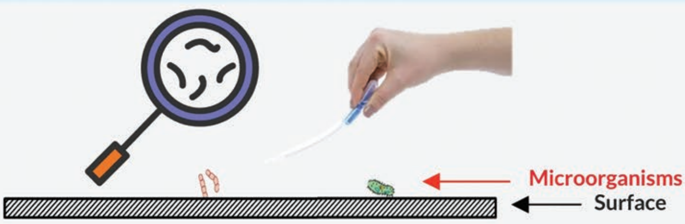



## 3. Sanitise

Use approved chemicals sanitisers at recommended concentrations and contact times for effective sanitisation. A proper cleaning step ensures interaction of sanitiser with potential pathogens present on surface.


## 4. Validation and verification

Validate your cleaning and sanitisation schedule as per the food safety plan. May use adenosine triphosphate (ATP) swab analysis to verify the surface has been effectively cleaned and sanitised.



# PACKHOUSE ENVIRONMENTAL MONITORING PROGRAM

## Steps and Strategies

### 1 PREVENT

Prevent the entry and establishment of foodborne pathogens.

### 2 CLEAN

Follow and maintain an extensive cleaning schedule.

### 3 SANITISE

After cleaning, ensure that a sanitising schedule is followed.

### 4 SEEK & DESTROY

Prepare and execute a plan to **SEEK and DESTROY** foodborne pathogens.

### 5 SWAB & SAMPLE

Swab and sample with the aim of finding positive test results to eliminate environmental pathogen risks.

### 6 VALIDATE

Execute microbiological testing to validate that cleaning and sanitisation schedules are effective.

### 7 REVIEW

Review test results to identify, assess and manage microbial food safety risks.

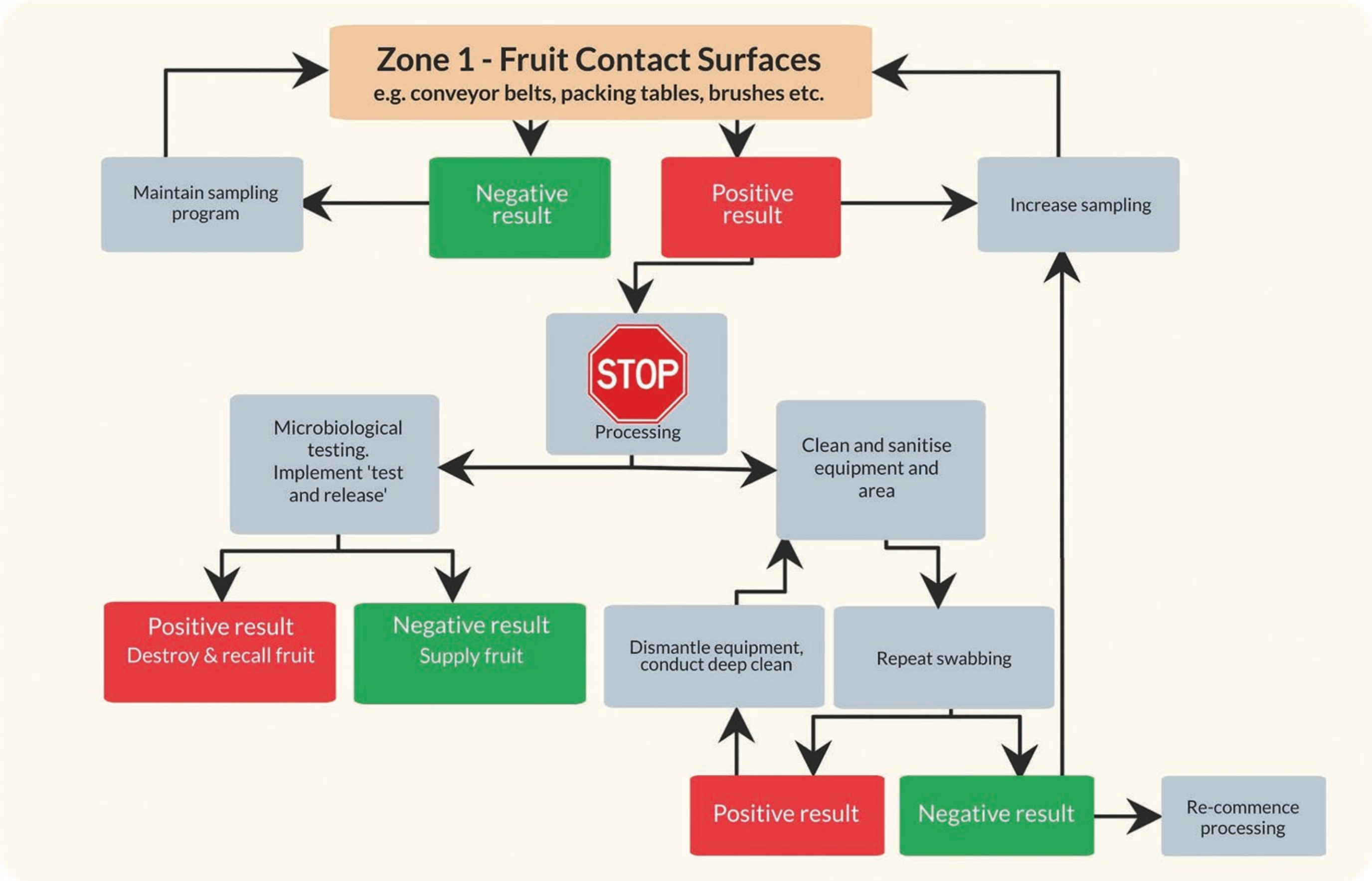
### 8 ASSESS

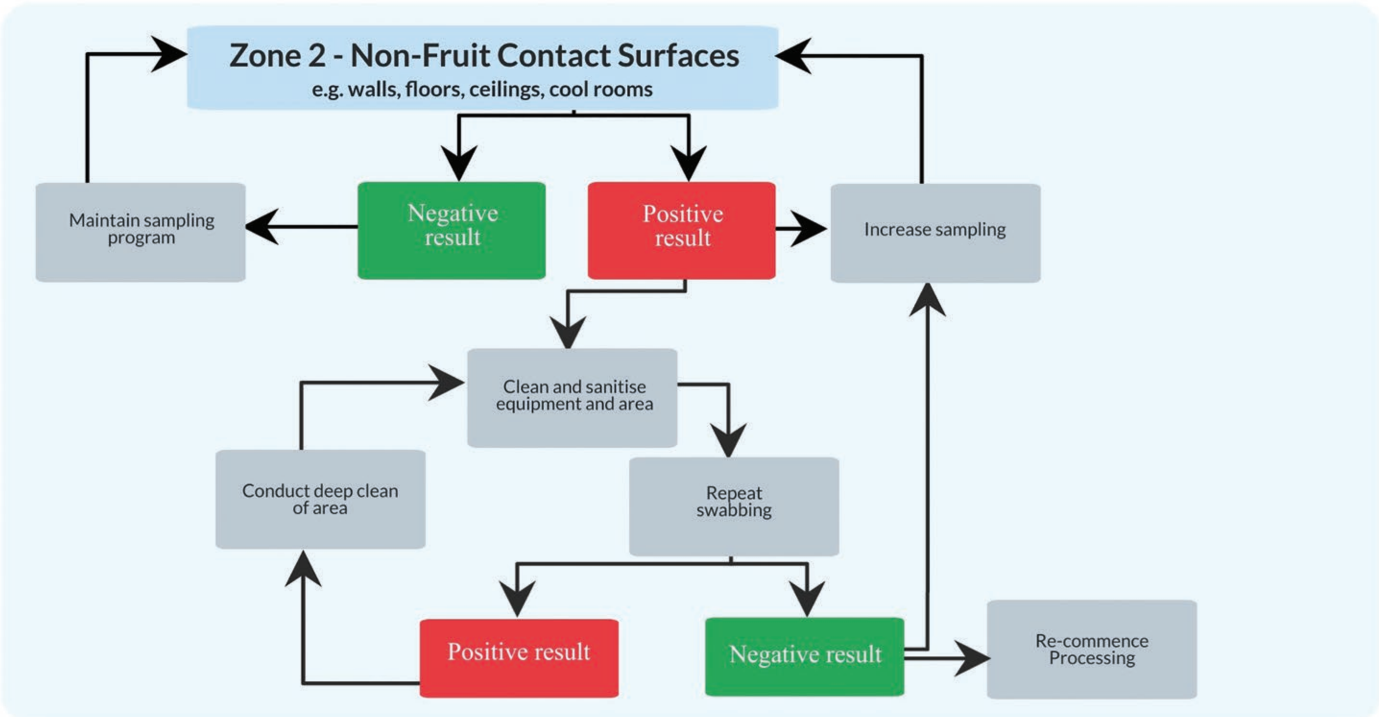
Review of overall results regularly to assess wider trends and measure overall progress.

### 9 REMAIN VIGILANT

Implement environmental monitoring program effectively and remain vigilant.

# RESPONDING TO MICROBIOLOGICAL TEST RESULTS



# DEVELOPING A STANDARD OPERATING PROCEDURE (SOP)

A standard operating procedure (SOP) is a documented set of instructions that describe a specific procedure or task. The SOP provides essential information including what is needed, who is responsible for the procedure and how exactly to perform the procedure. SOPs are operation-specific and SOPs for the same task will differ from farm to farm. SOPs are essential in ensuring different people are able to complete the same task consistently and safely.

**1 Determine goals for SOP**

- For example, the goal of an SOP for cleaning and sanitation of an equipment would be to reliably prevent and minimise the chance of equipment becoming a source of contamination rather than to ensure that equipment is cleaned and sanitised in a similar manner.

**2 Select SOP format**

- Formats include simple set of steps, hierarchical steps, graphical or flowcharts.
- Determine the number of steps in the procedure. If less than 10, use simple step format. If there are a lot of decisions throughout the procedure use a flowchart or graphic format.

**3 Identify key areas of concern for your operation.**

- Identify key areas of concern for your operation e.g. sanitiser concentration or cleaning and sanitisation of equipment.
- Observe someone performing the process and take note of everything they do. This becomes the first draft of an SOP.

**4 Review SOP internally and externally**

- Ask workers to review the draft SOP and suggest changes to make it easier to understand
- Consult with technical advisers such as microbiologists, researchers and quality assurance specialists.

**5 Validate/test SOP**

- Ask someone to follow the SOP as it is described. Observe and take down notes. Also ask someone unfamiliar with the task to follow the SOP.
- Steps that cause confusion should be revised and reviewed.

**6 Document and place SOP appropriately**

- Place a copy of SOP in the area where the procedure is conducted and in QA documentation.
- Essential SOPs can be included in employee handbooks.
- Periodic review of SOP to ensure any changes are updated.

# TIPS FOR WRITING A STANDARD OPERATING PROCEDURE (SOP)

- Use objective and active language e.g. "Measure sanitiser concentration" instead of "the concentration should be measured".
- Write steps as short sentences and list in chronological order.
- Ensure SOPs are direct and concise.
- Ensure any acronyms used are defined or well known.
- Avoid providing too much detail that the SOP becomes impractical.
- Ensure that there is enough detail to complete the process and all essential information is provided.
- Be sure steps can be easily implemented and followed.
- Ensure that the SOP is task specific, avoid including too many activities in one SOP.

# An example SOP for cleaning and sanitising harvest bins

**Disclaimer: this sample SOP is included for educational purposes and may not be suited to procedures on individual farms. Please read thoroughly and use these as guidance documents.**

| Standard operating procedure | |
|---|---|
| **Business name:** | |
| **Title:** | Maintenance, cleaning and sanitising harvest bins |
| **Procedure number:** | |
| **Number of pages:** | |
| **Function:** | e.g. Quality Assurance, Environmental Monitoring Program |
| **Implementation date:** | |
| **Revision number:** | 1.0 |
| **Author name:** | |
| **Signature:** | |
| **Date** | |
| **QA Officer/coordinator:** | |
| **Signature:** | |
| **Date:** | |
| **Approved by (name):** | |
| **Signature:** | |
| **Date:** | |
| **Approved by (name):** | |
| **Signature:** | |
| **Date:** | |

## Purpose

Describes how harvest bins are to be cleaned and sanitised.

## Scope

This procedure applies to all farm staff.

## Safety and health

### Risk assessment

- handling bins and lugs might pose risk of musculoskeletal injury if manual handling is involved in their movement, the risk being greater if containers are over stacked
- do not stack pallets and bins too high as this might lead to serious injury if stacks were to fall on anyone.

## Definitions

[Enter any definitions that will assist any needed clarification here]

## Responsibilities

- staff are responsible for following and conducting the SOPs to properly clean and sanitise containers, bins and lugs
- farm owners and food safety managers are responsible for training staff on proper techniques, providing necessary resources such as tools, potable water, detergents and sanitisers, and making sure the cleaning and sanitising steps are followed correctly.

## Materials

- personal protection equipment (e.g. gloves, shoes)
- high-pressure hose
- detergent [insert name of brand]
- sanitiser [insert name of brand]
- container(s) as needed for mixing and using detergent(s) and sanitiser(s) or for washing tools
- clean water (potable)
- brushes.

## Procedure

1. inspect all harvest containers at least weekly for damage and repair before being used in the field. Take out of circulation and dispose of any unrepairable containers
2. follow a cleaning and sanitising schedule after each product is harvested or at the end of each shift, whichever occurs most often
3. steps for the cleaning and sanitising procedure:
   - hose harvest containers with potable water (microbiological equivalent to drinking water)
   - remove any visible dirt and debris by brushing or rinsing
   - prepare detergent [add preparation and mixing procedure here as per manufacturer's instructions] and add it to the water used on harvest containers in order to dissolve organic loads such as soil
   - apply the prepared detergent solution and scrub surfaces (for large equipment scrub from top to bottom)
   - rinse the container with clean water until all soap is rinsed away (for large equipment do this from top to bottom)
   - prepare sanitiser [add preparation and mixing procedure here as per manufacturer's instructions]
   - apply the prepared sanitiser solution and allow it to sit for [insert duration of time as per sanitiser manufacturer's instructions] minutes
   - rinse with clean water
   - let the surface air dry.
4. only use cleaned and sanitised containers for harvested fruit. DO NOT store non-produce items in harvest containers. Employees should be informed that it is unacceptable to store personal items in harvest containers; this includes clothes, lunches and water bottles.
5. use a clean sealed area or pallets to stack and store clean harvest containers and new boxes. Stored containers should be covered with plastic when not in use. Wash all harvest bins including old and new at the beginning of production.

# Melon preharvest food safety checklist

| Preharvest | Yes | No | N/A | Comments |
|---|---|---|---|---|
| **Field assessment (location and history)** | | | | |
| Does previous use of the melon growing site present any physical, chemical or microbial contamination risks? | | | | |
| Do fields adjacent to the site present any physical, chemical or microbial contamination risks? | | | | |
| Do adjacent fields and their activity pose potential microbial risks? | | | | |
| Does the field's surrounding environment promote run-off to the plantings? (e.g. elevated surrounding areas, slopes) | | | | |
| Are there potential contributors to spray drift either in production areas or in adjacent fields? | | | | |
| Are there buffer zones to mitigate risks of run-off, spray drift and wildlife presence in and around fields? | | | | |
| Are there physical barriers such as fences to exclude animals and wildlife from production site? | | | | |
| Are the records of land history, hazard analysis, pre-plant field inspections and tests such as soil tests kept? | | | | |
| Has the site been inspected for any physical contamination? | | | | |
| **Agricultural water** | | | | |
| Has the water source been tested for its microbiological quality to meet compliance with the quality assurance program? | | | | |
| Is the water source (e.g. pond, dam) protected from run-off or flooding? | | | | |
| Is the water source protected from animal incursion and subsequent contamination? | | | | |
| Are there steps in place to minimise contact between irrigation water and the fruit? (e.g. drip irrigation) | | | | |
| Is there other activity associated with the water source? (e.g. livestock, wildlife or human activity) | | | | |
| Is drinking/potable water quality used to make up and deliver chemical sprays to plants? | | | | |
| Are records kept of the water source, water tests and associated activities? | | | | |
| Has a hazard analysis been conducted for the water source? | | | | |
| Are any bores or wells maintained and enclosed? | | | | |
| Are water storage tanks constructed with materials that will not contaminate the water? | | | | |
| Are water storage tanks clean and secured from any potential contamination (including deliberate contamination i.e. sabotage)? | | | | |
| Has irrigation equipment been flushed before use? | | | | |
| **Fertilisers and soil amendments** | | | | |
| Do you use raw animal manure? (Not recommended) | | | | |
| Do you use compost containing animal manures? | | | | |
| Is the compost used in fields appropriately treated and tested in accordance with Australian Standard AS 4454-2012 or equivalent? | | | | |
| Is the compost stored properly? | | | | |
| Are approved and certified compost suppliers used? | | | | |
| Are compost application and its microbiological quality test report documented? | | | | |

| | | | | |
|---|---|---|---|---|
| **Agriculture chemicals** | | | | |
| Are agricultural chemicals (herbicides, pesticides, fertilisers) labelled and stored correctly? | | | | |
| **Animal and wildlife management** | | | | |
| Is animal movement controlled to prevent microbial contamination? | | | | |
| Does the area have a high population of birds and wildlife? | | | | |
| Have you taken the necessary measures to manage wildlife risks? | | | | |
| Have you trained staff not to harvest the fruit with bird droppings? | | | | |
| Have you trained the field staff to report the signs (e.g. footprints, faeces) of animal and wildlife incursion to the farm manager? | | | | |
| **Harvest** | | | | |
| **Harvest bins and boxes** | | | | |
| Are appropriate harvest containers used? (appropriate size, material) | | | | |
| Are containers regularly inspected and replaced? | | | | |
| Are containers and harvest bins regularly cleaned and sanitised? | | | | |
| **Harvest equipment** | | | | |
| Is the equipment used for harvesting (such as gloves, clippers and conveyor belts) regularly sanitised following an SOP and schedule? | | | | |
| Is the equipment used for harvest constructed with materials that can be cleaned and sanitised? | | | | |
| Is harvest equipment only used for harvesting and not allowed to be used for other tasks? | | | | |
| Is there a means of disposing of culled melons that will not attract animals and pests? | | | | |
| **Sanitary and wash stations** | | | | |
| Are field staff provided with sanitary stations including wash stations having soap and paper towels? | | | | |
| Is there proper signage including hand washing technique? | | | | |
| Are toilets within a 5-minute walk or 400 m of all staff? | | | | |
| Are toilets and wash stations adequately supplied and maintained? | | | | |
| **Staff health and hygiene** | | | | |
| Are staff trained in the personal hygiene and field hygiene policies of the business? | | | | |
| Do staff understand their role and feel responsible for food safety? | | | | |
| Do staff have access to clean water, soap and single-use paper towel? | | | | |
| Is drinking water available for staff? | | | | |
| Are separate areas provided for field staff to use for tea breaks and meals? | | | | |
| Is there a toilet facility for every 20 staff? | | | | |
| Are reusable gloves cleaned and sanitised daily? | | | | |
| When using gloves, are they used appropriately and replaced regularly? | | | | |
| Is there a process to prevent staff who show signs of illness or have open wounds from handling produce? | | | | |
| Is there a staff illness and injury reporting system? | | | | |
| Do staff wear clean clothes daily? | | | | |
| Are field staff aware of cross-contamination risks and are they trained in its prevention? | | | | |

# Melon postharvest food safety checklist

| Postharvest | Yes | No | N/A | Comments |
|---|---|---|---|---|
| **Packhouse** | | | | |
| Are cold storage and pre-cooling facilities regularly cleaned and sanitised? | | | | |
| Is the packhouse closed off to the outside environment? | | | | |
| Are storage facilities kept free of pests including signs of pests e.g. droppings? | | | | |
| Are there rodent controls (e.g. baits) put in place and are they regularly maintained? | | | | |
| Are there any locations in the packhouse that could encourage birds to roost or nest? | | | | |
| Are there any bird controls put in place? | | | | |
| Are there any means for dust control? (e.g. plastic curtains) | | | | |
| Is the building and layout of the packhouse designed to prevent cross-contamination? | | | | |
| Is there direct access from the unprocessed fruit handling area to the processed fruit handling area? | | | | |
| Is sanitation equipment cleaned and sanitised regularly? | | | | |
| Is sanitation equipment stored correctly and kept separate from other equipment? | | | | |
| **Postharvest water** | | | | |
| Is drinking quality water used during processing and cleaning fruit contact surfaces such as harvest bins and conveyor belts? | | | | |
| Is postharvest water tested by an accredited laboratory? | | | | |
| If dump tanks are used, is water regularly replaced based on an objective measure of turbidity as per validated food safety plan? | | | | |
| Is the frequency of dump tank water replacement based on potential organic load on fruit depending upon weather such as dust storms and rainfall? | | | | |
| Is the sanitiser concentration monitored and maintained regularly in the dump tank as per your validated food safety plan? | | | | |
| Is the dump tank water temperature monitored? | | | | |
| Are roller brushes (overhead and flatbed) maintained and regularly cleaned and sanitised? | | | | |
| Are all roller brushes in contact with sanitised water sprays? | | | | |
| Are there successive washing steps rather than a single wash? | | | | |
| If tanks are used for storing water, are they sealed and designed in such a way to prevent animals and pests from entering? | | | | |
| Are appropriate concentrations of sanitisers used for wash water? | | | | |
| Are there appropriate methods (e.g. digital photometers and sensors) put in place to monitor sanitiser concentration at regular intervals? | | | | |
| If chlorine is used as a sanitiser, do you monitor the pH of the chlorinated water to ensure it is maintained between 6.5 and 7.0? | | | | |
| Is water ever recycled during the processing? | | | | |
| If water is re-used, is there a provision of water treatment to ensure drinking quality is maintained during its re-use for fruit washing? | | | | |
| Is water temperature monitored and recorded regularly? | | | | |

| Postharvest | Yes | No | N/A | Comments |
|---|---|---|---|---|
| **Postharvest water monitoring** | | | | |
| Are sanitiser concentrations regularly measured and monitored? | | | | |
| Have there been any undesirable results? | | | | |
| If yes, was any corrective action taken? | | | | |
| **Packhouse and equipment hygiene** | | | | |
| Are staff trained in a cleaning and sanitising program? | | | | |
| Is a training register kept? | | | | |
| Is there any equipment being used that is damaged or worn? | | | | |
| Is the equipment that is used for postharvest processing of fruit maintained, inspected and repaired regularly? | | | | |
| Are there any porous surfaces (generally used for cushioning) in the packing line? | | | | |
| Are fruit contact surfaces such as harvest bins, conveyor belts and brushes sanitised with approved food grade sanitisers and detergents? | | | | |
| Does the design of equipment allow for easy cleaning and sanitising? | | | | |
| Is there regular inspection and scheduled cleaning of racks and forklifts? | | | | |
| When garbage and waste are stored, is it covered? | | | | |
| Are packing materials stored in a hygienic manner? | | | | |
| Has a microbiologist/food safety expert been consulted to validate cleaning and sanitising procedures? | | | | |

# Melon food safety toolbox

## Practical resources for implementing best practice

NSW GOVERNMENT | Department of Primary Industries

Hort Innovation Strategic levy investment | MELON FUND