APRIL 2017

ALL ABOUT ALMONDS

CROP MANAGEMENT

MANAGING FOOD SAFETY RISKS IN ALMONDS

In common with many types of nuts, almond kernels are often consumed as a 'ready-to-eat' (RTE) food. RTE foods need to meet strictly prescribed food safety standards because they do not undergo further treatments that remove or reduce microbial contaminations.

KEY POINTS

- Almonds need to be maintained at the recommended moisture content to ensure optimum shelf life and safety.
- Exposure of almonds to wet conditions can encourage growth of micro-organisms, which leads to spoilage. Some microorganisms have the potential to cause food safety risks.
- This fact sheet lists best practice guidelines that can be implemented to limit contamination and growth of microorganisms during the growing, harvest and storage stages of the current almond production system.

BACKGROUND

In common with many types of nuts, almond kernels are often consumed as a 'ready-to-eat' (RTE) food. RTE foods need to meet strictly prescribed food safety standards because they do not undergo further treatments that remove or reduce microbial contaminations.

WHAT ARE READY-TO-EAT FOODS?

RTE foods are consumed in the same state as that in which they are sold or distributed, without further processing such as hulling, peeling, washing or cooking by the consumer.

WHAT MICROORGANISMS CAN POSE FOOD SAFETY RISKS?

For low moisture foods, such as nuts, two examples of potential food-borne pathogens are some *Salmonella* and *Listeria* species. These pathogens have been isolated from the environment, and can persist in the processing chain.

Microbial infections can lead to spoilage, production loss and degradation of produce quality. Certain fungi, such as *Aspergillus* spp., can pose food safety risks because they produce mycotoxins. Some of these fungi are commonly found in the environment and can colonise and survive on a wide range of hosts and substrates.

LOW TOLERANCES FOR FOOD-BORNE PATHOGENS AND MYCOTOXINS

Foods produced in Australia and exported to different overseas markets need to meet very low or nil tolerance for food-borne pathogens; and low tolerances for aflatoxins, in the level of parts per billion. Within Australia, major retailers have different food safety and quality assurance requirements. Therefore, adoption of production practices that prevent or limit microbial contamination will help with meeting the stringent quality and food safety standards.

WHAT CONDITIONS PROMOTE MICROBIAL GROWTH?

Microbial species known to be found on foods can grow over a wide temperature range. For example, the temperature range for *Salmonella* spp. is 5.2-46.2°C, with an optimum of 35-43°C. *Aspergillus flavus* can grow in the range of 10-38°C, with optimal growth at 32-33°C. These temperature ranges also prevail in orchards, soils and stockpiles (Fig 1). This means these temperatures are unlikely to limit the growth of these microbial species.

WHY IS IT IMPORTANT TO KEEP NUTS DRY?

Both temperature and moisture have a major influence on microbial growth and mycotoxin production. These conditions also have a major impact on the quality and shelf life of low moisture foods such as almonds. Microorganisms grow best when water is readily

Large Rhizopus inoculum load on a hull rot infected fruit.

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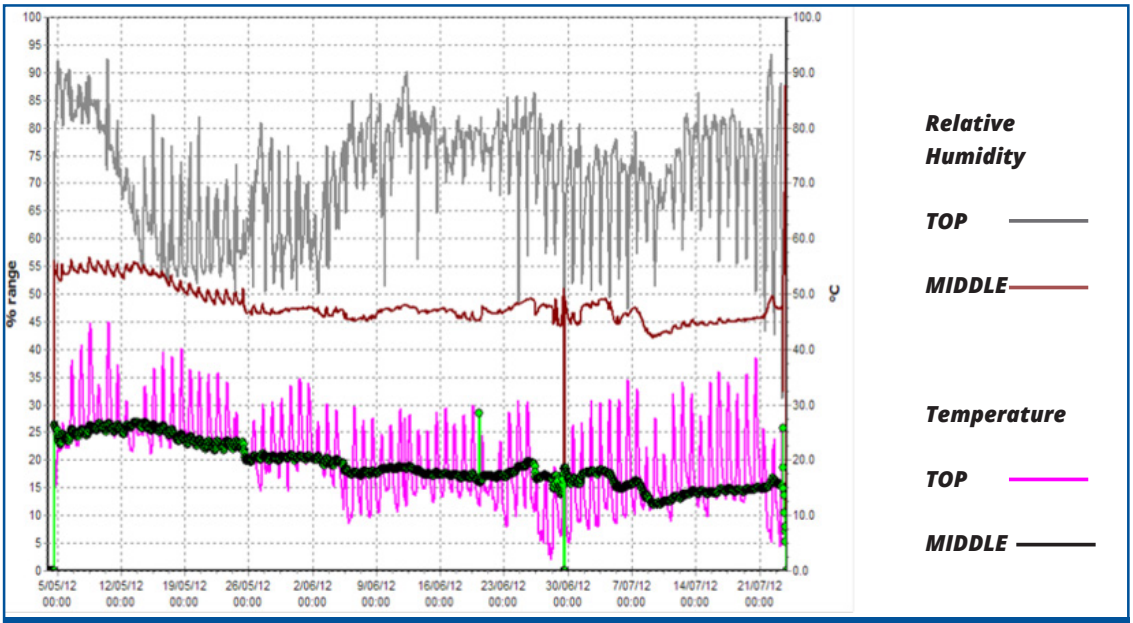

Figure 1. *Large fluctuations in the relative humidity and temperature in the top layers of a stockpile covered with a clear tarp.*

available in the substrate; this is described as the water activity (a_w). Controlling moisture content is one of the most important factors for limiting microbial growth in low moisture, RTE foods. The lower a_w limit for growth of *Salmonella* is 0.94, whereas the level is lower for *Aspergillus* spp., at 0.80. This means Aspergilli can grow on substrates with a low a_w. For this reason, almonds are best maintained at optimum a_w levels of 0.3-0.6. It is recommended that the moisture content of almond kernels should not exceed 5-6%.

Almonds can absorb moisture from an environment with high relative humidity (RH). The hulls of whole almond fruit have greater capacity than the kernels to absorb moisture, this helps to retain moist environments in stockpiles (Fig 2). Therefore, prior to dehulling, it is important that stockpiles are kept dry to prevent migration of moisture into the whole fruit and kernels.

WHAT IS WATER ACTIVITY?

Water activity (a_w) refers to the water requirements of microorganisms in a particular food or substrate. It is a measure of the ratio of water vapour pressure of the food substrate to the vapour pressure of pure water at the same temperature.

Therefore, the RH and temperature of the storage environment has an influence on the a_w of a food product.

Even when dry nuts are loaded into stockpiles, moisture can still condense on the under surface of the commonly used PVC tarps. The condensation will contact the surface layers of stockpiles, run off and pool around the base, valleys and pockets of depressed spots in the stockpiles. This creates prolonged moist conditions if the stockpile is not uncovered and aerated.

Research has shown that tarps made of breathable, waterproof material enable release of moisture from the stockpile, minimising the quantity of almonds in the at-risk zones of stockpiles and helping them to remain dry over several months.

RISK PROFILES OF ALMOND ORCHARDS AND STOCKPILES

The potential areas of risk during production and stockpiling of almonds are summarised in the Table 1. The risks are categorised as low, medium and high to direct focus on key areas that need risk mitigation.

Table 1. *Ranking of microbial infection risks in almond orchards and stockpiles*

LOW	MEDIUM	HIGH
Green fruit on trees	Mummies on the ground	Nuts on wet orchard floor at shaking & drying
Mature fruit on trees	Dry nuts and/or kernel on the ground	Moist nuts/kernels on the ground
Dry nuts	Mechanically damaged kernels	Storage of nuts exposed to moisture
Dry, hard shelled nuts	Nuts/kernels damaged by insect/ rodent/bird feeding	Storage of insufficiently dried nuts
Low microbial inoculum levels	Over-wintering nuts on ground	Poor drainage of water from stockpads
Low organic matter on ground	Clean and dry orchard floor	Condensation build up/run off under tarp
No over-wintering nuts on ground		Lack of aeration of damp stockpiles
		Damp nuts/kernels in the surface layers, in gullies and depressed spots of stockpiles
		Damp nuts/kernels in the basal layers near or on wet ground of stockpiles

WHAT MEASURES CAN BE IMPLEMENTED TO REDUCE FOOD SAFETY RISKS?

Based on the above risk profiles, a range of orchard and stockpile management options can be implemented to reduce microbial infections or contaminations in almonds.

Because these microorganisms are present in the environment and can grow in the temperature range that prevails in the orchards and stockpiles, measures that can mitigate these risks need to focus on: (1) preventing contamination, and (2) limiting microbial growth.

An understanding of which aspects of orchard and storage operations that have the potential for almonds to be exposed to or increase the risks will help to target the control measures.

Therefore, targeting the critical control points in the growing and storage operations will have a major impact in preventing or reducing microbial contamination, to ensure the raw almond materials are clean and of high quality, prior to undergoing processing, pasteurisation or manufacturing processes.

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It is recognised that orchard and stockpile management approaches vary between different growers and processors. Some growers are already HACCP accredited. Processors have HACCP and SQF2001 (Safe Quality Foods) accreditation, and almond products are tested by third party laboratories with NATA (National Association of Testing Authorities) accreditation, these serve to ensure products are of high quality and safe. The following guidelines aim to highlight a range of measures that can be adopted/adapted into existing practices to firstly prevent contamination, and secondly, to further limit microbial growth.

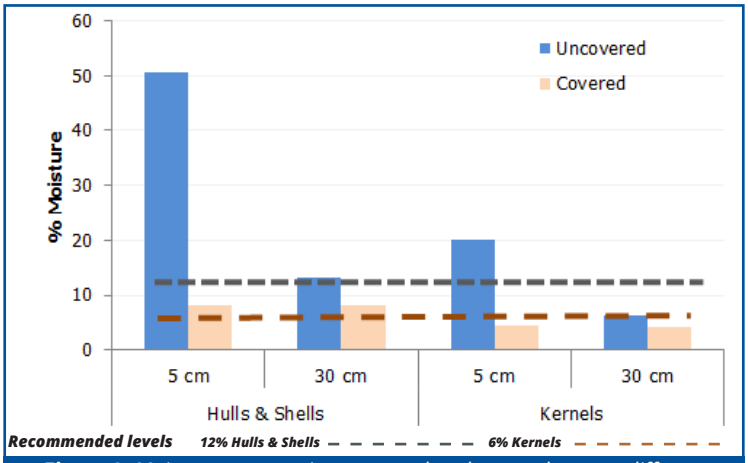

Figure 2. *Moisture contents in uncovered and covered nuts at different stockpile depths after rain exposure.*

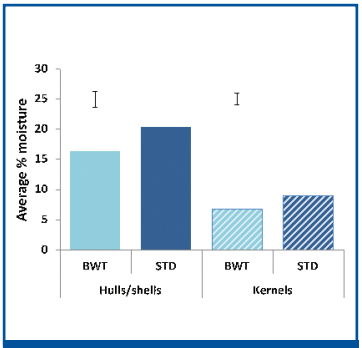

Figure 3. *Hulls/shells and kernels in the top of stockpiles covered with a BWT have lower % moisture than those covered with a standard PVC tarp (STD).*

ORCHARD MANAGEMENT

- Reduce hull rot infection and minimise damage by insect pests such as Carob Moth and Carpophilus beetles.
- Remove mummies from previous season/s.
- Ensure good pollination to minimise early abortion of inadequately pollinated nuts, which become substrates on the ground for microbial infection.
- Improve light penetration and air circulation in tree canopy to enhance drying of nuts.
- Prune large overhanging limbs, so that nuts do not become damaged or knocked off by orchard machinery.
- Manage irrigation and nutrient feeding to enhance drying of nuts.
- Remove nuts left on the orchard floor, alternatively, encourage breakdown of nuts to remove overwintering substrates for microbial infection, insect and rodent feeding.
- Ensure hull piles are not dumped near orchards or stockpile sites. Dispose of or encourage breakdown of hull piles.

PRE-HARVEST

- Avoid shaking if rain is forecast.
- Prepare orchard ground before harvest, pre-sweep to remove trash and branches, and infected or infested nuts.
- Ensure orchard ground is level and not prone to ponding of water.
- Inspect irrigation lines so that there are no leaky drippers.

AT HARVEST

- Monitor nut moisture contents and ensure nuts are dry (kernels <6%, whole nuts <9%, hulls <12%) prior to pick up for stockpiling.
- Ensure sufficient equipment capacity is available to harvest, sweep and pick up quickly before exposure to rain.
- Avoid turning on irrigation whilst nuts are still on the ground under the tree canopy.
- Sweep nuts from under the tree canopy into the windrows to aid faster drying of nuts.
- Where resources are available and logistically feasible, a shake-and-catch approach for young trees will help to avoid drying of nuts on the ground. This reduces the risks of rain exposure and cross-contamination.
- Remove nuts on young trees that are not old enough to be shaken so that these do not act as infection/infestation sites for hull rot, *Aspergillus* spp., Carob Moth and Carpophilus beetles.

POST-HARVEST

- Reshake to remove left-over nuts from the trees as they provide carry-over inoculum for hull rot and act as overwintering sites for pests.
- Collect and clear nuts from orchard floor.
- If the reshaken nuts are not collected for processing, sweep nuts into the windrow and flail mow these to encourage break down so that they do not become a substrate for microbial infection (e.g. hull rot), or a food source for almond pests.

STOCKPILE MANAGEMENT

- Segregate nuts from at-risk orchard blocks into separate stockpiles, e.g. nuts exposed to the rain, or those harvested before reaching optimum dryness.

Figure 4. *Condensation under a clear tarp* *Image Source: ABA*

Figure 5. *Covering stockpile with a breathable, waterproof tarp*

Image Source: Chin Gouk, Agriculture Victoria

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- Segregate nuts from orchard blocks with high levels of pest infestation, e.g. Carob Moth or Carpophilus beetles.
- Ensure good hygiene in stockpads and surrounding grounds. Remove and dispose of any old nuts around the stockpad.
- Ensure stockpad or storage ground is well compacted and gently sloped to drain away water from the base of stockpiles.
- Orientate the long side of the stockpiles in a North-South direction to reduce the area prone to shading.
- Improve construction of stockpiles to minimise formation of troughs on the ridges and slopes where condensation accumulates.
- Avoid widespread spilling of nuts around the base of stockpiles to prevent too many nuts being on wet ground, i.e. using an elevator to create steeper edges rather than spreading edges around the base of stockpiles.
- If a bunker is not available, avoid creating a spreading stockpile base as it is prone to damage by machinery.

STOCKPILE COVERAGE & AERATION

- Cover stockpiles with an opaque, waterproof tarp to protect nuts from the rain or heavy dew.
- Avoid use of a clear tarp unless frequent aeration can be conducted (Fig 3).
- Use a breathable, waterproof tarp (BWT) that enables moisture to evaporate from the stockpile (Fig 5).
- Ensure stockpile tarps are wide enough to extend to cover the ground surrounding the base and to prevent moisture seeping back into the stockpile.
- Avoid putting tyres or heavy objects on stockpile slopes to hold down the tarp, as they create depressions for condensation to accumulate (Fig 6). This in turn encourages microbial growth. Instead, place these objects on the part of the tarp that covers the ground.
- Ensure effective fumigation of stockpiles for insect control.
- Aerate stockpiles to dry off condensation that accumulates under PVC tarps and run-off onto the top surface and depressions in stockpiles.
- Avoid mixing wet nuts with dry nuts to prevent migration of moisture and spreading of fungal and bacterial loads to dry nuts.
- Shed storage provides better protection from the rain. Consider this option if economically viable.

PICK UPS

- Shorten stockpile duration as much as possible.
- Ensure trucks and trailers are clean before they are used to transport nuts.
- Remove and segregate mouldy and rotten nuts in damp patches in stockpiles to minimise contaminating other kernels, the hulling and shelling plants and grading machinery.
- Test nut moisture content before hulling and cracking to form decisions on drying requirements.

MORE INFORMATION

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Figure 6. *Damp, mouldy nuts under tyres*

Image Source: Chin Gouk, Agriculture Victoria

Figure 7. *Damp and mouldy nuts*

Image Source: Chin Gouk, Agriculture Victoria

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