

International Organisation of Spice Trade Associations

**GENERAL GUIDELINES
FOR
GOOD AGRICULTURAL PRACTICES ON
SPICES & CULINARY HERBS**

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American Spice Trade Association
World Spice Organisation

There are a number of spice specific guides that give advice on the growing and harvesting of spices. The growing and harvesting of spices is a complex matter and is dependant upon the local conditions, whether they are climatic conditions, soil conditions, varieties available and the agricultural practices followed.

As a point of interest they can be viewed via the Internet from the following sources –

Spices Board of India
International Pepper Community
America Spice Trade Association
World Spice Organisation

www.indianspices.com
www.ipcnet.org
www.astaspice.org
www.wsospice.org

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INTRODUCTION

Spices are dried seeds, fruits, berries, leaves, roots or bark of plants grown as herbs, shrubs, climbers and trees, used to enhance the flavour of foods. Examples include cumin, chilli, black pepper, oregano, ginger, and cinnamon.

Like any other agricultural product, spices and culinary herbs may be contaminated by pathogens, naturally occurring toxins such as mycotoxins, agrochemicals such as pesticides, heavy metals, and accidental contaminants. Food safety is assuming considerable significance in the globalized era, both because of its health significance and economic importance. The safety of spices and culinary herbs depends on maintaining good agricultural including hygienic practices along the food chain during primary production, post-harvest, packing, processing, retail and at the point of consumption. Reconditioning is carried out throughout the supply chain to remove both foreign and extraneous matter, to improve the microbiological status or to improve the quality. However, for spices and herbs it is virtually impossible to recondition for the following potential contaminants:

- Mycotoxins
- Heavy metals
- Pesticide residues
- Allergens
- Undeclared colours
- Processing aids

In such a scenario, the only option is to prevent these potential contaminants from either getting into the product or being formed during post harvest handling.

Purpose of the Guide

This guide is intended to aid producers of spices and culinary herbs in the prevention of the occurrence of the contaminants or to ensure that if present, the levels are acceptable from a food safety and legislative perspective. The purpose of this guide is not to duplicate the effort made by the existing guides, but to produce a specific document to the growing and post harvest handling of spices to ensure that the parameters that cannot be reconditioned, once the material has been dried for sale, are adequately addressed in the countries growing and handling spices and herbs. The guide extends a little beyond agricultural practices in recognition that the control of these non-reconditionable aspects does not just stop at the point of harvest to the contaminants. In addition, allergenic materials, environmental colours and processing aids are also aspects that can be issues associated with primary processing in a more agricultural environment and thus these too are addressed in this guide. This guide is not intended to be used as a reference point for good manufacturing practice as this area in itself should be the subject of separate and complimentary guide. Instead of reinventing the wheel, existing information from various sources are collated in this write-up.

Importance of GAP

Good Agricultural Practices or GAP are "practices that need to be applied on farms to ensure food safety during pre-production, production, harvest and post-harvest. In many cases such practices also help protect the environment and safety of workers". They are a collection of principles to apply for farm production and post-production processes resulting in safe and healthy food and non-agricultural products while taking into account economic, social and environmental sustainability. Their purpose varies from fulfillment of trade and government regulatory requirements, in particular with regard to food safety and quality, to more specific requirements of specialty or niche markets. In addition to facilitation of market access, reduction in non-compliance risks regarding pesticide residues and microbial and other contaminant hazards may be achieved. GAP schemes are predominantly consumer driven and incorporate traceability requirements as an important part of their food safety measures.

MYCOTOXINS

Introduction

Among the many subjects affecting food safety are contaminants caused by mould formation. Some moulds produce toxins that can be harmful to human health. Collectively these are known as mycotoxins. For spices there are two -mycotoxins of concern, ochratoxin A (OTA) and aflatoxin. These are potentially carcinogenic to humans. Aflatoxins are produced by moulds/fungi of the genus *Aspergillus* and ochratoxini A is produced by both *Aspergillus* and *Penicillium* - hence one of the reasons why OTA can be produced in temperate storage.

They are predominantly produced by two fungal species, *Aspergillus* and *Penicillium*. The toxin cannot be removed by further processing nor inhibited by heat treatment.

Ochratoxin A and aflatoxins are found in many foodstuffs, predominantly in fruit and cereals but also it is sometimes found in spices, however globally aflatoxin appears to be the toxin of concern.

These moulds will typically grow on foodstuffs that have been subjected to high temperatures and elevated humidity levels. Note: OTA can be formed at lower temperatures. Similarly it has been shown that, while the initial contamination may occur at farm level, the actual mycotoxin formation may happen throughout the entire supply chain, in every stage of transportation, storage and production.

Preventative measures taken by all stakeholders in the chain from field to fork are the best way to prevent mould formation and thus enhance spice quality. The Authorities in consuming countries have already set maximum permitted levels for aflatoxins in spices and are currently discussing limits for OTA. Presence of these toxins, above the permitted levels, will result in the destruction of these deliveries.

This Code of Practice is intended to assist operators throughout the chain to apply Good Agricultural Practices, Good Practices in Transport and Storage and Good Primary Processing Practices preventing mycotoxin formation.

Growing Controls

In general terms spices will have few mycotoxins problems if the spice is healthy and undamaged. Nevertheless, contact with any obvious sources of fungal contamination (soil, poor water quality and mouldy spices) should be minimised to help the spices natural defences.

Harvesting

The soil under the plant should be covered with a clean sheet of plastic during picking to avoid fruits getting contaminated by dirt or mixed up with mouldy fruits that have fallen prior to harvesting. Fallen fruit and leaves should be removed from the area as they provide the correct growing conditions for moulds.

Fruits that have fallen to the ground are known to be susceptible to mould growth. Fruits that are affected by mould or infected should be removed. Alternatively, the raw spice fallen to the ground should be collected separately, washed, cleaned, dried and evaluated prior to any inclusion within the main lot.

Process fresh spices as quickly as possible. Avoid storage of fruits, especially ripe and over-ripe ones, as any period of storage (in a bag or in a pile) increases the likelihood of mould growth. Wherever possible start drying on the day of harvesting.

Wherever possible a system for differential harvesting should be applied, so that once products are ripe they are harvested. This ensures good quality and helps prevent mould growth and mycotoxins generation from overripe fruits.

Wet Processing (if applicable)

The above procedures (dry processing) should be used following the wet processing of product, such as the washing and peeling of Ginger. Particular attention should be paid to spices once they have been removed from the wash tanks.

For reasons of microbiology and other contaminants it is essential that any wet processing is done using potable water.

Once the product has been removed from the water it is best practice to remove any excess as quickly as possible so that the combination of excess water and heat does not encourage microbial growth.

Sun Drying

Do not dry on bare soil. Use trays, tarpaulins, bamboo mats or drying yards and make sure that these are clean as it is known that mould spores from previous use could re-contaminate product during drying. Techniques for cleaning all of the above should be taught to the farmers.

The layer of drying fruits or leaves should not be more than 4 cm thick.

Drying fruits or leaves must be regularly raked (5-10 times per day).

Protect fruits during drying from rain and night dew and make sure that any fruit does not get any re-wetting during storage or any other time.

Drying areas should be raised from the ground to prevent pest ingress and the potential effect this could have on mycotoxins generation, amongst other issues.

Pathways should be made in the drying area to prevent anyone walking on the crop, as this can damage the pods and allows mould growth to occur.

Controlled Drying

To give better quality, reduced bacterial loads and ensure less risk of mycotoxin growth a system of controlled drying can be employed.

Solar drying is one method, where crops are protected in polythene tunnels and the temperature is controlled through the use of air movement. Such tunnels should be designed so that the risk of condensation falling onto the drying crop is eliminated.

Hot air drying can also be employed and care should be taken to ensure that there is no risk of fumes from the fuel coming into contact with the product. This can be best achieved through the use of a heat exchanger so that only clean air comes into contact with the product.

A solar heat exchanger can also be used where hot air generated from the sun's rays on a heat exchanger are fed into a unit which contains the spice spread on a fine wire mesh.

Dry Processing

The site processing plant should be in a dry area, as moist, humid conditions such as those found on swampy land, encourage the growth of mould.

There should be separation between raw material receipt, cleaning, washing, processing and storage, to prevent any cross contamination.

Dispose of waste from wet processing, such as the washing and peeling of ginger, away from clean dry spices.

Keep equipment and facilities clean, make sure they have any debris removed prior to using and make sure the equipment is dry before use.

Use clean dry bags for storing and transporting dry, cleaned spices and keep dried spices away from any damp material or areas.

Processing should achieve a uniform moisture content that is as low as feasible and certainly not higher than 12.0% using ISO 6673 as the measuring method or using equipment calibrated to the same standard. Other comparable methods, such as AOAC, may also be used for this analysis.

The drying area should be elevated, to prevent pest ingress and potential flooding, and should be constructed of a material that will not contaminate the spices in question.

A concrete pad can serve this purpose and in this case it should have a slightly sloping surface to allow water to run away from the product and should have a perimeter fence to prevent farm animals, pets, pest etc. from walking on the crop as it is drying.

It is important to ensure that the drying yard is cleaned prior to use.

Storage and Transportation

Under this chapter it must be stressed that, in view of the importance of temperature and humidity in relation to the formation of moulds and hence the possible occurrence of mycotoxins, improper harvesting, drying and rewetting are by far the most significant risks.

Product should be stored in good, well maintained warehouses that do not allow the ingress of water whether through leaks in the roof or walls or under doors, through open windows etc.

It is also important to ensure that product is stored off the floor and away from the walls so that any potential condensation does not rewet the product. In addition there should be good air movement through the warehouse to prevent sweating and mould formation.

Temperatures within large warehouses can achieve levels ideal for mould growth, particularly towards the roof, thus suitable ventilation should be provided to ensure that both temperature and humidity are correctly managed.

When product is moved into or out of the warehouse ensure it is protected from the rain during transportation.

Make regular checks to ensure that the truck is covered and that there are no rips in the covers and no leaks on the undersides of trucks which would allow water from the road to get into the truck. Check from the inside by closing all doors and looking for holes where daylight is visible.

Trucks must be clean, dry and odour-free. This also prevents cross contamination from previously transported products (see allergens).

Do not load and unload trucks if the product is exposed to rain. Provide shelter so that the spice does not get wet during this operation.

Containers

Do not use damaged containers. Ensure there are no water leaks. Rust spots on the roof and sides of containers can be an indication of leakage. Check from the inside during daylight hours by closing all doors and looking for holes and undesirable smells.

Ensure that the containers have not been previously used for dangerous and hazardous cargoes according to the criteria set by IMCO (International Maritime Organization). These are cargoes such as solid or liquid chemicals and other materials, gases and products for and of the oil refinery industry, and waste chemicals and other cargoes which have a damaging effect on foodstuffs.

Make transit times as short as possible and avoid long stops to ensure that excessive heat does not build up within the container. In particular do not stuff any container too soon as it could get very warm sitting around awaiting shipment.

Preferably use a shaded area or put another container on top to help to minimise the temperature increase within the container. The roof of an unprotected container can reach temperatures of over 80°C. The subsequent cooling off during the night results in condensation on the internal walls.

Stuffing and Shipping

Make sure that pallets or wooden floors of containers are dry. Spices absorb moisture quickly if the bags get wet and as a result the moisture content increases considerably.

Lining a container using cardboard, (single-side corrugated and waxed on the inside) has proven to be the best protection against condensation for bags in containers. Kraft paper has also been used successfully. Control that the lining is properly fastened, particularly in the ceiling so that the lining will not fall down and settle on the top bags

When stuffing the container, bags or bulk, keep spices away from the roof. Bags should preferably be placed on a layer of pallets to avoid contact with the floor where condensation from the ceiling and walls may gather

If available, fully ventilated containers are preferable for spices in bags, especially if shipped from a high humidity origin. Alternatively the standard dry container with added paper / cardboard protection (top, sides and doors) is fully acceptable.

Ventilation holes in the container are to be kept clear. Do not cover with tape.

Absorbent poles or boxes filled with calcium chloride absorb around 100% of their own weight in moisture and may be used for added protection if parties so agree. The number of bags used should be recorded on the documentation so that when being unloaded, they can all be accounted for. It is important that care is taken not to damage these dry-bags and any spillages should be cleaned up immediately.

Enough top space between bags and the roof is important. Use the saddle stow method, which minimises side contact and maximises airflow between the bags.

The storage, transportation and shipping advice in this section is also applicable to all other sections of this document.

HEAVY METALS

Introduction

Heavy metals are chemicals that are known to be toxic to humans and are often impossible for the human body to metabolise. Therefore, their presence needs to be controlled, and should not exceed the Codex maximum residue limits, to prevent a build up in the body over a period of time.

Within the spice industry a number of potential heavy metal problems exist, and, whilst their presence is not currently considered to be a major problem, this guide offers advice to ensure that their presence in spices is prevented.

Typical heavy metals found in spices are lead, cadmium, zinc, tin, arsenic and copper.

Potential Sources

It is important that in spice growing and processing areas the disposal of batteries, whether car or portable device batteries, should be disposed of correctly to ensure that they do not decay and contaminate growing areas.

A monitoring programme should be established to ensure that any naturally occurring heavy metals, for example from natural ores present in the soil, do not become a potential problem for the spices. This is particularly important for spices where ore is processed locally having the potential to contaminate the local water supply.

PESTICIDE RESIDUES

Introduction

The use of pesticides is often a key requirement in ensuring that products are produced in an economic manner and are supplied to the market free from insect damage.

As our understanding about the effect of pesticide residues on the human population increases it is now key that any potential residues present are controlled, to both demonstrate good agricultural practices and protect the well being of the consumer.

Integrated Pest Management (IPM)

The principle of integrated pest management is to have a systematic approach to the use of plant protection chemicals so that their residues do not become a problem.

IPM uses methods and disciplines that take care to minimize environmental impact and risks, and optimize benefits. It is a systems approach to pest management that utilizes decision making procedures based on either quantitative or qualitative observations of the pest problem and the related host or habitat.

A key concept in IPM programmes is the application of decision making processes to determine whether a chemical pesticide or other action is needed or not. Such decisions depend on evaluation of the pest problem often in a quantitative manner.

In the evaluation of agricultural crop pests, the point at which the economic benefit of pesticide use exceeds the cost of treatment is commonly referred to as the economic threshold. Academic definitions of the threshold concept may vary from discipline to discipline. Another term commonly accepted is action threshold, which is commonly applied to a set of conditions where action is warranted and may be based more on practical experience and judgment than on refined mathematical models relating biological and economic parameters.

Since IPM decision making depends on field observations, the role of the pest scout, pest management advisor, or field biologist has emerged. Although do-it-yourself field observations may be widely practiced, most IPM programmes require a person in the field to collect relevant information on the pest populations in question and related parameters concerning the crop or host habitat.

In addition, the restricted use of plant protection chemicals not only has the benefit that there is less chance of pests becoming tolerant to those chemicals but also has the benefit of achieving higher quality products within the m

Growing Location

The location of the growing area should be such that there is no additional risk of pest or disease attack of the plant due to the growing environment. This could be by ensuring that materials are grown away from waste disposal areas, or that they are

grown away from other plants which are known to attract high levels of pests or disease.

For any growing area it is important to identify which crops are growing adjacent to that area and also pay particular attention to any crops that are non food that are sited up wind of the growing area. If these crops are non food, such a cotton, when pesticides are applied the wind can carry these pesticides on to the food crop resulting in detectable levels of pesticide that are not permitted for a food crop.

The presence of weeds within a growing area not only competes for nutrients but also encourages pests into the area. Before using weed killer chemicals mechanical removal of the weeds should be undertaken wherever possible.

Pest Monitoring

The use of trap crops, ie those crops that are more attractive to a particular pest than the spice being grown, can have a significant effect in identifying any potential pest before the level of pests become unacceptable. For example, a trap crop of castor can be a very good indicator of potential pest activity within a capsicum growing area as the pests that attack capsicums are more attracted to castor than they are to capsicum. In this scenario, regular inspections of the trap crop helps to identify any potential pest problems at an early stage in the process and removal of any affected leaves helps reduce pest population.

The use of pheromone traps within a growing area not only helps to reduce the target pest by capturing them but also allows close monitoring of the pest so that when plant protection chemicals are applied it is done in an appropriate manner.

The use of perimeter crops, where perhaps a band of crop is grown around the spice growing area, not only prevents physical entry to the growing area for pests but can also help reduce wind drift effects and insect attacks.

The use of bird perches within a growing area can have the benefit of providing a perch for the bird to roost and thus the bird will stay in a particular growing area and will eat a proportion of any pests that are present on the crop. Wherever possible these bird perches should be located so that they are not directly above any individual plant, thus reducing the risk of bird excreta on the plant, and should be removed for a period prior to harvesting for the same reason.

Irrigation

With regard to disease spread it is better if trickle irrigation can be used as this has the benefit of ensuring that water supplies are used sparingly and also has the benefit that if plant protection chemicals are required these can be delivered directly to the plant.

Flood irrigation techniques use excessive amounts of water and also increase the risk of spreading disease throughout any particular growing area.

Pesticides

If plant protection chemicals are required then, wherever possible, natural systems such as neem can be used as these types of plant protection chemicals are more acceptable to the importing countries.

When synthetic plant protection chemicals are used it is important that these chemicals are permitted for the crop in question. It is important to establish whether this permission also extends to any country where it is envisaged the crop will be exported.

It is important that when a plant protection chemical is used that it is purchased from an authorised dealer who can give assurances that the chemical that they are selling is authentic. PPCs should not be purchased from any other source as the active principles in these chemical may be at the wrong concentration or could even be prohibited chemicals.

Once acceptability of the plant protection chemical has been established the levels of dose for a crop should be set which not only establishes the dilution to be used but also the number of applications that are permitted.

There should be documentation on the use of plant protection chemicals. This should include their trade name, their active chemical ingredient, the product expiry date, the date that it is applied, the dilution that has been applied and also the target pest in question.

Plant protection chemical operatives should be provided with suitable equipment to ensure that they can dose the plant protection chemical correctly, especially when this is done at field level. In this case the use of measuring cylinders, or measuring caps, as some plant protection chemical manufacturers provide, will ensure that the application level is acceptable and thus residue will be within accepted tolerances.

It is important that the equipment being used for pesticide application is washed thoroughly to ensure that there is no cross contamination from previous use.

A pesticide holiday, typically a period of 10 days where pesticides are not applied, will help ensure that any plant protection chemicals used have the opportunity to dissipate throughout the plant prior to harvesting. Note: many plant protection chemicals state on their labels the minimum length of time that should be allowed between the last application of the chemical and the harvest and this advice should always be taken into account.

It is important that pesticide containers, whether pouches or bottles, should be disposed of correctly and not left within the growing fields where the application was carried out.

It is important that any water used for irrigation is tested to ensure that it is free from pesticide residues from other crop run-off further upstream.

ALLERGENS

Introduction

For reasons that are still to be fully understood it is now clear that in some parts of the world more and more people are becoming sensitive to potential allergens. This sensitisation can, in some instances, result in anaphylactic shock with the smallest amount of food ingredient causing this problem. It is therefore particularly important to ensure that spices are protected from potential allergens if they are destined for use on the world market.

Details of applicable allergens are posted on the IOSTA section of the ASTA website.

Cross Contamination

Particular attention should be paid to ground nuts (peanuts) as it is now clear that these pose one of the highest risks for certain consumers and therefore it is imperative that during the growing, processing, storage and transportation periods that spices are protected to prevent contamination from peanuts.

Care should be taken when rotating crops to ensure that a previous allergenic crop is has not left any potential cross contaminants in the growing area.

It is also important that peanut derivatives, such as ground nut oil, are not used in any way for the processing of spices or for the lubrication of any spice processing equipment.

With regard to allergenic materials that are sensitizers it is important to ensure that spices are kept separate from cereal products containing gluten, such as wheat, and other allergenic materials such as Soya beans and tree nuts.

Care should be taken while harvesting spice and allergen crops which are grown side by side in the same area. If the harvest is more or less during the same period a suitable harvest gap should be given among these crops to avoid contamination.

Certain spices have now been classified as having potential allergenic properties. It is therefore important that systems are put in place to ensure that when these spices are grown or processed there are suitable clean-down systems to ensure that there is no carryover of these spices into other spice products.

At present the list of spices that come into this category are; Mustard, Celery and Sesame seed. In some countries Coriander is considered as an allergen, so please check the website for the most up to date information (see www.astaspice.org)

It is now clear that certain consumers have allergic reactions to the presence of sulphur dioxide. Traditionally sulphur has been used within the spice industry, either to improve the visual appearance of spices or as a pest prevention method. The risk associated with sulphur dioxide should be carefully considered within any HACCP study.

In the EU, for example, if a spice contains more than 10ppm of sulphur dioxide residues then it has to be clearly labelled as such so that the consumer can make an informed choice as to whether they should purchase and eat this material.

One area that needs careful consideration is the transportation of spices, especially from farm to exporter or processing unit, where in the past it has not been uncommon for bags to be recycled for this purpose. In this instance it is important that these recycled bags are suitably controlled and that if they have had allergenic materials present then they are not used for spices.

Care and attention should be taken in any common trading yard, where both allergenic materials and spices are handled, to prevent cross contamination. A suitable cleaning operation needs to be adopted to ensure this risk is eliminated.

ENVIRONMENTAL COLOURS

Introduction

It is well documented in recent years that there has been an occurrence of deliberate adulteration of spices with artificial colours. In some cases these colours were not permitted as food colours and in other case these colours were not declared and thus were deemed to be misleading to the consumer.

As a result of these adulteration incidents it became clear, through the thorough investigation that was carried out by the spice industry, that it is now possible using the most up to date analytical equipment to detect the presence of very low levels of colour which can be present in spices due to environmental contamination such as marking inks, colours to assist in applying plant protection products, fuel or dye contaminated water.

Bag Markings

To ensure that spices are not coloured when bag markings are used a food grade dye should be used wherever possible.

Bags that have an open structure, such as jute bags, should not have bag marking made on the jute when the bag is already full of spices. In this case the use of liquid dyes can go through the bag and contaminate a small portion of the contents so it is better that the bags are marked prior to filling or are marked using a label or tag.

Plant Protection Chemicals

When purchasing plant protection chemicals particular attention should be given to the colour of any chemical purchased. Highly coloured pesticides have the risk of leaving minor traces of colour on the crop, especially if there has been a late application in the growing cycle.

Fuel Emissions

The fuel used for transportation and water pump operation is often coloured. Consideration should be given to the location of these pumps to ensure that the fuel itself or its exhaust residues do not add to the environmental and colours contamination. In addition, consideration should be given to the location of growing areas to avoid vehicle exhaust emissions becoming a problem if there are high traffic levels next to the growing area.

PROCESSING AIDS

Introduction

With regard to this guide a processing aid is a chemical that is used to help improve the processing of spices whilst it has no technological function within the finished spice.

For many years bleached spices have been a traded commodity, such as ginger, cardamom etc, and it is important that their packaging declares this bleaching and that the residues of any bleaching conform to international guidelines.

For many years there have been a number of processing aids used in spices and thus it is important that it is fully justifiable, safe and gives the buyer an informed choice.

Any processing aid must be food safe and approved for use within the country of consumption, and declared to the buyer.

White Pepper

During the manufacture of white pepper, microbial reduction agents such as Chlorine are used to ensure that the quality of the processing water is maintained. If agents like this are used then their dose should be controlled to prevent a carry over from the process onto the finished products, and the final product levels should be in accordance with International standards.

Where this type of process is used it should be declared to the buyer so that he is aware of this and can make any labelling declaration required.

Dressing

The use of mineral oil to coat the surface of black pepper, paprika or other spices is not permitted. The use of vegetable oil (not peanut oil for reasons mention earlier in the guide) should be declared to the buyer.

GENERAL

Worker Hygiene

Personnel handling the harvest should not be suffering from any contagious disease which will cause or act as a precursor to cause food born health problems. In the event of observing such signs of diseases the person responsible for supervising the harvesting should take the necessary measures to prevent the person(s) from handling the harvest until they are fully cured from the disease(s).

Basic sanitary practices should be practiced by personnel before and during harvesting and handling of harvest.

Where ever possible, especially in primary sorting centres or drying yards, care should be taken to prevent the potential ingress of glass. This includes the removal of jewellery, the replacement of windows with non glass material (such as Perspex), prohibiting the use of any glass container or bottle, etc.

Workers involved in the handling of spices should be aware of the risk of contaminating the crop and thus eating and drinking should be prohibited in these areas.

Field Sanitation

The field sanitation standards require the person supervising the harvesting of the crop to provide toilets, potable drinking water and hand-washing facilities to personnel in the field, ensure that each person reasonable use of the above and make sure that each person understands the importance of good hygiene practices.

MICROBIAL CONTAMINATION

Introduction - Food Safety Begins on the Farm

Outbreaks of food borne illness make news headlines around the world on a regular basis. In the U.S. alone, it is estimated that as many as 48 million people contract some type of food borne illness each year. As a result, over 128,000 are hospitalized and about 3,000 deaths occur.

All agricultural commodities carry the risk of being contaminated with pathogenic bacteria. From planting to consumption, there are many opportunities for bacteria, viruses, and parasites to contaminate produce. On the farm, soil, manure, water, animals, equipment, and workers may spread harmful organisms.

How much food borne illness originates on the farm? *No one knows*. Are there reasonable steps that a grower can take to reduce the risk that pathogens will contaminate the food produced on the farm? *Absolutely*.

There is no way to guarantee that everything we grow and consume is free of harmful microbial contamination. However, the risk can be reduced if preventative steps are taken before produce leaves the farm. This guide contains detailed suggestions on how you can reduce risks of microbiological contamination on the farm.

Clean Soil

The improper use of manure can be a risk factor contributing to foodborne illness. Pathogens such as *E. coli* 0157:H7, *Salmonella*, and *Campylobacter* can be present in manure slurry and soil for three months or more, depending on temperature and soil conditions.

Composting manure, incorporating it prior to planting, and avoiding top-dressing with fresh manure are important steps that can reduce the risk of contamination while making use of this important source of nutrients. Excluding domestic and wild animals as much as possible from production fields will help reduce the risk of manure (fecal) contamination.

Manure Application

Manure should not be applied to the crop area for three months prior to harvesting. If the field is side dressed with manure, only well composted manure should be used and care must be taken to make sure it does not touch the crop. Fresh manure and liquid manure should not be used once the crop is in the field.

Irrigation Water

When using surface water for irrigation, test quarterly for fecal coliforms, especially if water passes close to sewage treatment or livestock areas. Water may be filtered or put through a settling pond to improve water quality.

Use potable water for crop protection sprays, such as fertilizer, herbicide or pesticide application.

Where feasible, use drip irrigation to reduce crop wetting and minimize the risk of microbial contamination and spread of contamination or disease. If overhead irrigation is used, use it early in the day, so that leaves dry quickly and thus microbial growth is minimized.

Clean Hands

Attention should be paid to worker hygiene in the field especially during harvesting and during any on farm post harvest treatment. Workers who pick, sort, grade, or pack produce must wash their hands after using the restroom. Hepatitis A outbreaks have been linked to infected workers. Teach workers about microbial risks. Provide soap, clean water, and single-use towels in the field and insist that all workers wash hands before handling harvested products.

Clean Surfaces

Before harvesting or packing and at the end of each day, clean all bins or container that are being used.

Harvesting and Post Harvest Processing

Do not use decayed, mouldy or wormy fruit and remove any excess soil from crop before it is put into the transfer container. Do not use fruits that have been lying in contact with the soil for long periods of time, unless specific programs are in place to remove the contamination risk. Make sure that water used for produce washing, dipping, and soaking is drinkable (potable).

As some spices undergo primary processing at the farm level, ensure that any equipment used, such as pepper threshers, etc. are thoroughly cleaned before being used. This is particularly important on equipment that has been sitting unused since the last harvest. Equipment like this should be cleaned to remove product debris before it is put into storage, to prevent pest and microbial contamination during the storage period.

Ensure that any vehicle used to transport that crop around the farm is clean and dry. Pay particular attention to the previous use of the vehicle and clean it accordingly.

Sun Drying Operations

Ensure that sun drying surfaces are cleaned prior to use. If the cleaning involves water, ensure the water is potable and make sure the surface is dry before placing the crop on the surface. Through elevation or perimeter controls make sure that domestic animals, agricultural animals and pests are excluded from the sun drying area. Ensure that sun drying surfaces have sufficient slopes to prevent water from pooling. As with the mycotoxins guidance in this document, ensure that product is dried in thin layers and turned regularly to ensure that microbial growth during drying is prevented.

On Farm Storage

Sun dried product should be stored in an area that is free from contamination and where the product can be kept dry. The area should be able to be pest proofed to prevent contamination. The storage area should be well ventilated to prevent mould growth and it should be inspected on a regular basis.

Transportation

The vehicle being used for shipping should be cleaned prior to loading for shipment. Particular attention should be paid to the truck's previous use; it should be dry, pest free and undamaged. If the truck is open, a suitable tarpaulin or other cover should be used to prevent the crop from getting wet during transportation.

Worker Hygiene

In addition to the practices mentioned above, make sure that workers who are sick are either excluded from areas where they could contaminate the product or are given no food handling jobs. Provide workers with a suitable area where they can take a break, educate them on hygienic practices, and provide them with hand wash facilities. Ensure that workers understand the food safety risk of smoking or eating, and where appropriate prohibit these activities.

CONCLUSION

As the use of spices continues to expand and develop it is now even more important to ensure that all stages of the supply chain play their role in ensuring food safe products, which are free from potential hazards, are provided to the global consumer market.

Global food safety standards continue to develop, as do analytical techniques, and thus it is important to ensure that if you are using this guide you are using the most up to date version.

For additional information and resources, contact the IOSTA office at info@astaspice.org.