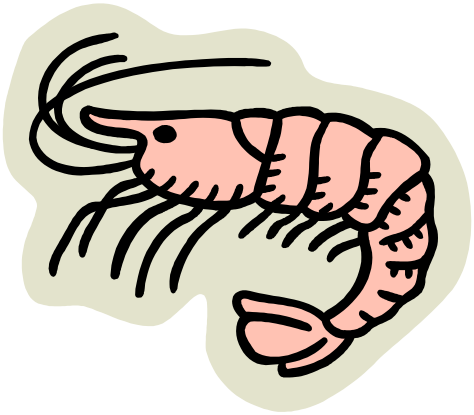
FARM-RAISED SHRIMP



Good Aquacultural Practices
for
Product Quality and Safety

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FARM-RAISED SHRIMP

GOOD AQUACULTURAL PRACTICES
for
PRODUCT QUALITY AND SAFETY

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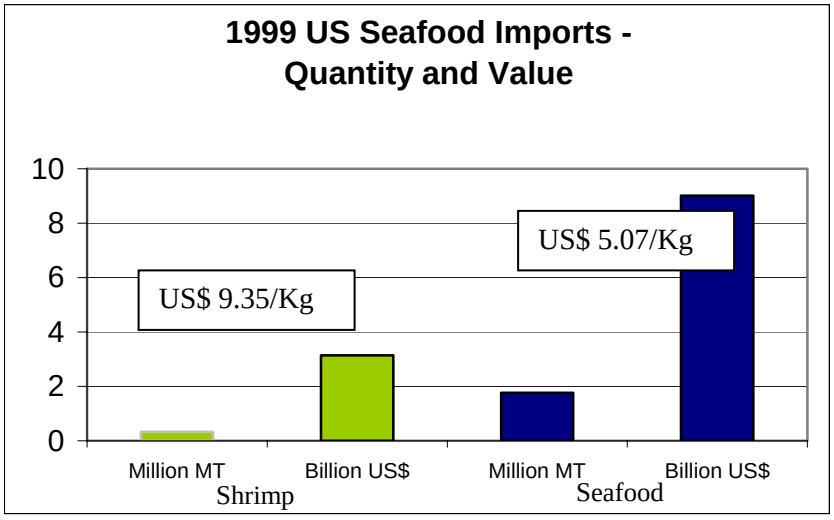
FARM-RAISED SHRIMP

IMPORTANCE OF PRODUCT SAFETY AND QUALITY

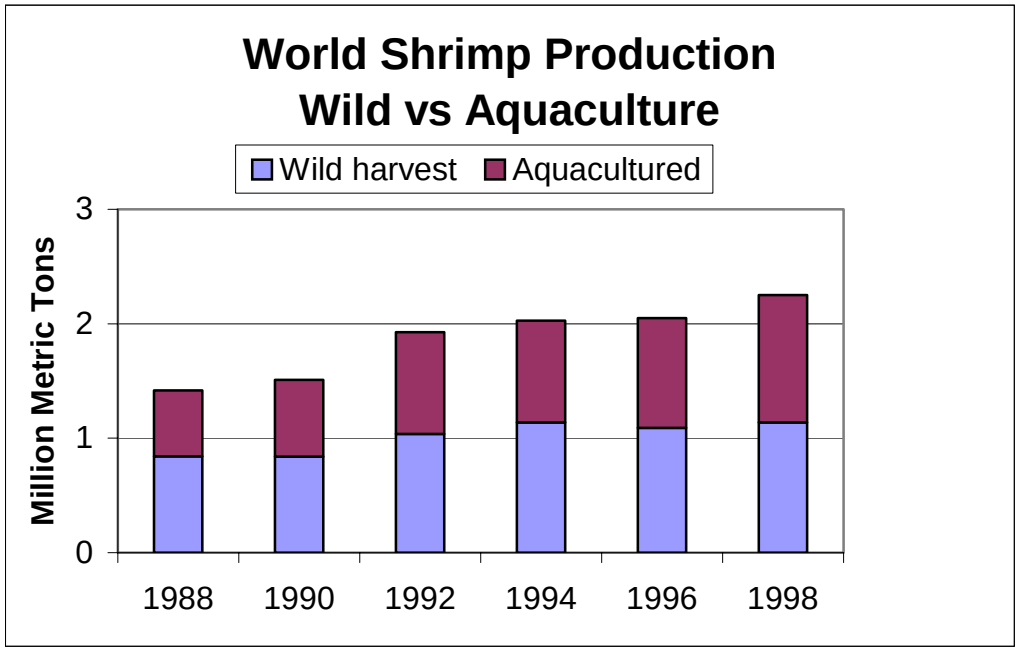
MARKET EXPECTATIONS

Shrimp remains as one of the most popular and highest valued seafood selections throughout the world. Current annual world production from both wild harvest and farm culture is estimated at approximately 3,000,000 metric tones with an estimated production value in excess of $12 billion U.S. dollars. In comparisons, shrimp production is not one of the largest world fisheries, but it is one of the most valuable. For example, in the United States the 1999 shrimp imports represented 18.8 percent of the total US imports by weight and 35 percent in total value. This value indicates a strong market demand. In some countries, consumption of farm-raised shrimp has grown to exceed the amount of wild shrimp.

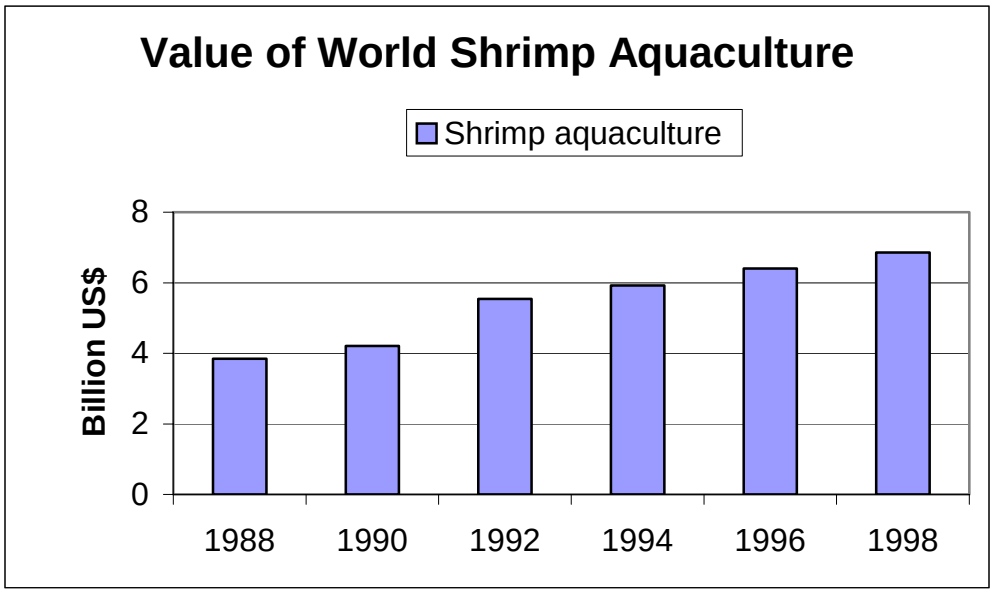


Source: WWW.NMFS.GOV , Foreign Trade data, 2001

While most world fisheries are experiencing maximum sustainable production or near overfishing, shrimp production can continue to increase through aquaculture farm operations. Shrimp aquaculture keeps growing steadily despite the adverse conditions and new challenges faced by the farmers. In 1988, farmed-raised shrimp represented 40.6 percent of the total shrimp production worldwide, increasing to 49.4 percent in 1998.



Source: WWW.FAO.ORG FishStat Plus 2000



Source: WWW.FAO.ORG FishStat Plus 2000

The growth of shrimp farming assures a positive future for the world shrimp supply, but this new industry is rapidly changing with expansion into more countries, by increasing use of more intensive farming, and through use of formulated feeds. Traditional food markets are usually suspect for a new source and new method of food production. Continuing demand and value for new shrimp products will depend on consistent product quality and safety. Market concerns include:

- Is the new shrimp as good as or better than the traditional shrimp?
- Does it taste and smell the same?
- Does it look the same, raw or cooked?
- Does it cook the same?
- Does it have the same shelf–life, when fresh or frozen?
- Is the new shrimp safe to eat?
- Does harvest and processing cause contamination with chemicals?
- Does harvesting and processing cause contamination with pathogenic bacteria?
- Do farmed animal illnesses (i.e., viruses) cause human illnesses?
- Do the farmers and processors practice good basic sanitation, hygiene and food safety standards (HACCP)?

These are reasonable and expected market questions for all foods, but the answers to these questions are becoming more difficult as the food supply becomes more distant and global. In fact, the ability to answer these questions has become a marketing advantage. This competition involves:

- farmed vs. wild shrimp supplies;
- country vs. other country shrimp supplies; and
- farm vs. other farm shrimp supplies.

In addition to the requirements for daily shrimp production, farmers must realize that the demand and value of their shrimp will depend on the product quality and safety.

“SHRIMP SAFETY & QUALITY = VALUE”

IMPORTANCE OF PRODUCT SAFETY AND QUALITY

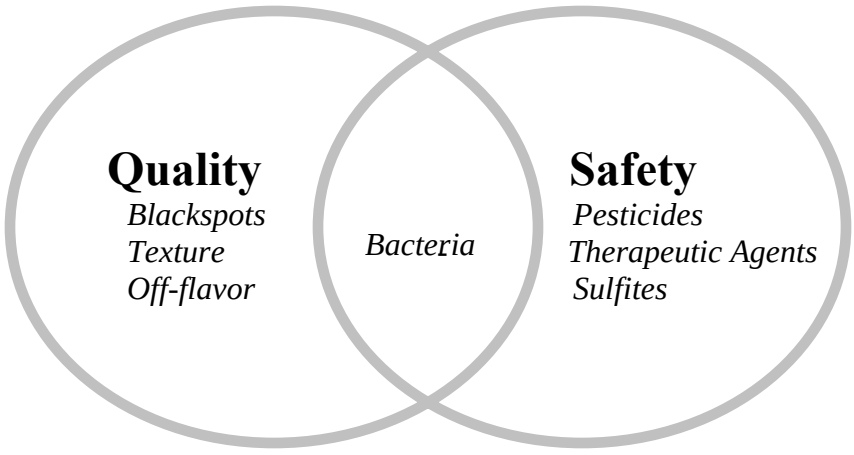
REGULATORY EXPECTATIONS

Shrimp farmers must be aware of the current regulatory expectations in their country and in the countries where their shrimp will be sold and consumed. The regulatory authorities in most nations are assigned to protect the 'safety' of their consumers. Most countries have specific regulations to assure food safety for products produced in or imported into the country. In many instances, these food safety regulations also involve or influence product quality. Regulatory expectations will be based on judgments and measures for both shrimp safety and quality.

Shrimp quality and safety are closely related. A shrimp with poor quality due to bacterial spoilage could be considered safe to eat if it is cooked to eliminate any safety concerns, but the poor quality is often considered an indirect measure for product safety. Likewise, an apparently good quality shrimp could cause illness if it is contaminated with a potential food hazard that is not obvious based on quality judgments. Regulatory authorities should try to distinguish certain safety problems. Farmed shrimp could be unsafe to eat if –

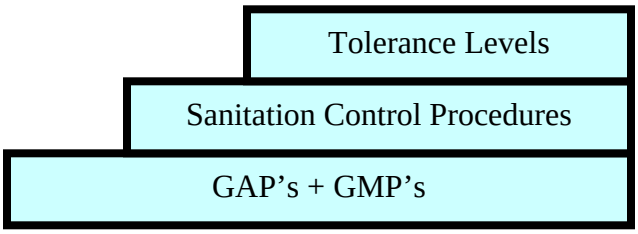
- the shrimp are contaminated with certain types or amounts of 'pathogenic' bacterial;
- the shrimp contains excessive amounts of food additives or improper food additives;
- the shrimp contains pesticides, herbicides or other potential toxic chemicals introduced during pond culture; or
- the shrimp contains improper amounts or type of therapeutic chemicals used during pond culture.

Areas of Concern for Shrimp Quality and Safety



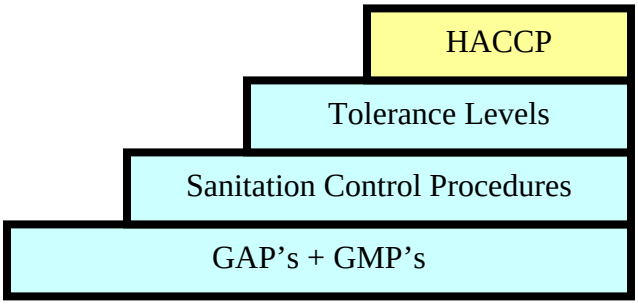
The traditional regulatory approach has been to set various guidelines or tolerances that assure a safe product. These standards are usually enforced by inspection of products after they are processed, combined with occasional inspections of the processing facilities to enforce good manufacture practices (Support Topics: GMP's). The GMP's include some basic sanitation requirements that are usually designed for processing. Good aquacultural practices (GAP's) are introduced to include farming activities linked with processing.

Traditional Steps to Food Safety



As with market expectations, regulatory authorities are usually more suspect for any new sources or methods of production for most foods. This concern has been most recently demonstrated by many nations adding food safety requirements based on Hazard Analysis and Critical Control Point (HACCP) programs. These requirements place more attention on 'prevention' of potential food safety problems before they occur rather than the traditional approach of inspecting or trying to find problems after they have occurred. The HACCP approach does not replace the traditional regulatory approach. It is in 'addition' to the traditional approach and depends on a solid foundation of sanitation, and the GMP's and GAP's.

Current Steps to Food Safety



The HACCP programs add requirements to document or record routine practices during the farm production and later processing of the shrimp. These records are the evidence that proper hygiene and sanitation control procedures have been used when growing, harvesting and processing the shrimp. The key HACCP feature is monitoring of certain 'critical control points' to maintain specified limits that assure the shrimp are safe to eat. Typical HACCP records for farmed raised shrimp can include:

1. Therapeutic Agents Application Record (see page 20)
2. Feed / Weight Control Record (see page 21)
3. Pre-Harvest Product Evaluation Record (see page 25)

1. Therapeutic Agents Application Record

Farm Name:_____

Location:_____

Pond Number	Shrimp Illness	Therapeutic Agent Used	Application Method	Dosage	Withdrawal Time (Days)	First Application date / time	Last application date / time	Applicator	Harvest Date

2. Feed / Weight Control Record

Farm Name:_____ Farm Location:_____

Pond Number:_____ Seeding Date:_____

Day	Month	Month	Month	Month	Month	Month
1						
2						

3. Pre-Harvest Product Evaluation Record

Pond #_____

Date	***First Evaluation***			***Second Evaluation (if needed)***			***Third Evaluation (if needed)***		
Parameter	**√ / X**	**Corrective Action(s)**	***Ready to Harvest (Yes/No)***	**√ / X**	**Corrective Action(s)**	***Ready to Harvest (Yes/No)***	**√ / X**	**Corrective Action(s)**	***Ready to Harvest (Yes/No)***

The traditional and new regulatory expectations realize that shrimp product safety begins in the pond. Farmers can no longer depend on the processor to eliminate or reduce potential problems. Farmers and processors must work together to maintain the quality and safety of the shrimp during culture, harvest, processing and distribution to markets.

"SHRIMP QUALITY & SAFETY = ACCEPTANCE"

FOOD QUALITY CONCERNS FOR FARMED SHRIMP

Shrimp quality is essential to maintaining product value. Poor quality cannot only reduce value, but could build a poor reputation for a particular farm, processor or an entire country. As for product safety, certain controls must be used to maintain quality. The following list of problems and controls is based on industry experiences, buyer specifications and some related regulations for shrimp produced and sold about the world.

Quality Concerns	Defects	Preventative Measures
Appearance	Blackspots	Proper application of sulfite or Everfresh
	Broken & damaged	Proper handling and icing
	Heat discoloration	Timely placement of product in ice
	Loose heads (whole product)	Proper loading and handling of product in ice
	Red heads	Stop feeding 48 hrs before harvest.
	Soft Shell (Whole and Shell-on product)	Harvest at the proper time based on periodic checks
	Yellowing	Proper use of sulfites
	Pitted or gritty shells	Proper use of sulfites
	Milky shrimp	Culling from the harvest
	Mixed Species	Separation by species at the plant
Odor / Flavor	Decomposition	Timely placement of product in ice
	Chlorine	Use proper concentration & exposure time
	Petro-chemical smell	Prevent contamination with oil, diesel, etc
	Choclo / Earthy Smell	Sensory test before harvest
	Off-flavors in the head	Sensory test before harvest
Texture	Mushy and /or soft texture	Proper shrimp to ice ratio and timely placement of product in ice
Processing Defects	Short weight	Routine checks for proper specifications
	Off-counts	
	Uniformity	
	Dehydration	Proper glazing and packaging
	Extraneous materials	Proper culling

"CONTROLS ARE REQUIRED TO PREVENT, ELIMINATE OR REDUCE QUALITY PROBLEMS"

FOOD SAFETY CONCERNS FOR FARMED SHRIMP

Shrimp remains one of the safest sources of seafood in the world. Food safety problems are rare, but certain problems can result in significant illnesses and costly damage to the industry and product reputation. The following list of potential food safety problems is based on actual market experiences and scientific evidence that indicate these problems are 'reasonably likely to occur' for farmed shrimp. All of these problems can be eliminated or reduced with appropriate controls.

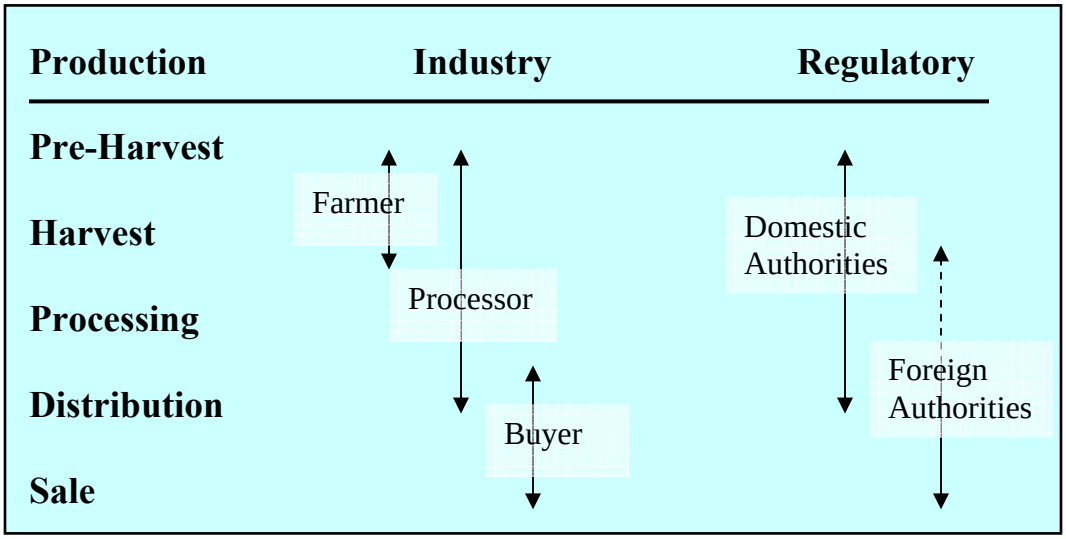
Food Safety Concerns	Controls
Biological Pathogenic bacteria - *Salmonella spp.* - *Vibrio cholera* - Pathogenic *Escherichia coli*	Increase culture water exchange, use of antimicrobial agents, or divert product to value added application. Determine the contamination source and apply controls.
Chemical Pesticides - Pesticides from agriculture - Insecticides, rodenticides, & other chemicals -	Do not apply pesticides in the vicinity of the ponds or the feed. Be aware of application of these compounds in adjacent agricultural farms. Prevent contamination through run-offs.
Herbicides - Chlorphenoxy compounds - Triazine herbicides, & others	Do not apply herbicides in the vicinity of the ponds or the feed. Be aware of application of these compounds in adjacent agricultural farms. Prevent contamination through run-offs.
Fertilizers and Water Treatment Compounds - Ammonium compounds, Calcium phosphate, Phosphoric acid, Potassium chloride, Sodium silicate, Lime, hydrated lime, & limestone	Fertilizers and water treatment compounds are normally not considered to be a food safety problem., but you should not apply fertilizers close to the harvest date.
Other contaminants - Heavy metals, i.e. methyl mercury	Cadmium, lead and mercury are the most commonly found heavy metals in seafood products., but they are not normally considered as a food safety concern in shrimp.
Therapeutic Agents - Oxytetracycline, Oxilinic acid, Furazolidone, Quinolona, & Terrivet	The use of these compounds is a major concern in shrimp aquaculture and controls are needed. The farmer needs to be aware of which product is approved or not for the country where the product will be shipped. Records need to be kept on the usage and recommended withdrawal times.
Food Additives - Sulfites	Sulfites are known to cause an allergic-type reaction in certain hyper -asthmatic consumers. For this reason, if sulfites are used, product needs to be properly labeled and control of applications by proper concentration and soak time is necessary.
Sanitizer residues	Proper labeling and proper use of cleaning and sanitizing compounds is essential to prevent any contamination on the product. Use proper concentrations and proper exposure time.
Physical - Debris - Filth	Filth and debris are normally considered to be a quality defect and not a food safety issue. Both of these problems need to be minimized to avoid problems at the port of entry of the receiving country. Both problems can be reduced by proper culling and sequential washes following the harvest.

"CONTROLS ARE REQUIRED TO PREVENT, ELIMINATE OR REDUCE SAFETY PROBLEMS"

CONTROLLING PRODUCT QUALITY AND SAFETY

The farmers, processors and buyers share responsibility for the quality and safety of farmed shrimp. The areas of responsibility begin before harvest and continue during product distribution. Proper controls are required during – shrimp growth, pond harvest, processing, and eventual distribution and storage. Due to market and regulatory expectations the processor usually assumes continuous responsibility from production to final sale. The farmers should form a team effort with the processor to assure proper controls are used during pre-harvest or pond growth and actual harvest operations.

Areas for Responsible Controls



Likewise, regulatory authorities in the country where the shrimp are farmed are expected to serve as a "competent authority" or third party providing surveillance and assurances that the shrimp are produced and processed to provide safe products for in-country and world commerce. The authority and how it is used should support the shrimp farming industry and provide information that will attract and build buyer confidence. Farmers and processors should work in cooperation with these authorities to assure the market value for their shrimp.

PRE-HARVEST CONTROLS

Pond growth or growing conditions can have the most significant influence on the final product quality and safety for farmed shrimp. Quality is usually best at the moment of harvest and the methods for processing and distribution are designed to maintain this initial harvest quality. Although the product form and appearance can be changed, it is difficult to impossible to improve the product quality after harvest. Likewise, it is difficult to improve product safety after harvest. Methods can be used to decrease any harmful bacteria or reduce any chemical contaminants, but these methods require additional processing costs, and the products are still subject to further regulatory scrutiny. Thus a successful shrimp farm depends on more than the production rate or pond yield. The initial harvest quality and safety can influence processing cost, regulatory approval and market acceptance.

Pond Care

Location

What has been the historical use of the land?

Prior uses of the land for the pond site plays an important role in the chemical quality of the soil. If the shrimp farm is developed on land previously used for agricultural farming, there might be accumulation of pesticide or herbicide residues that could affect the growth and proper development of the shrimp and safety of the final products. Prior to building a shrimp farm the farmer needs to know the following:

- Was the land used for agricultural corps?
- What was the agricultural crop grown on the land?
- What fertilizers, pesticides or herbicides were used with these local crops?
- Does the soil contain levels of agrochemical residues?

To answer some of these questions the future farmer may need to test the soil for chemical contaminants. After the farm is operational, the farmer may need to conduct periodical chemical analysis if contamination is suspected or the shrimp ponds are near active agricultural land or chemical spraying.

Why is the location of the farm important?

Shrimp farms can be impacted by their surroundings, through the water supply, direct contact with animals, or airborne contamination (i.e. chemical sprays). Occasionally, the farms are located near potential contamination sources, such as active livestock farms or any other industrial or sewage effluents. If the farm is located near an active agricultural or livestock farm or a community or settlement, farmers may need to monitor the impact of these activities. Agricultural lands that use pesticides and heavy fertilization on a

regular basis, could adversely impact the growth and the safety of the farm-raised animal. There is a potential human health hazard associated with the consumption of foods harvested from waters with chemical contamination. The risk for illnesses associated with these products is usually very low and requires more long-term exposures, but it remains a food safety problem that must be controlled. The farmer should try to learn –

Agricultural activities can affect shrimp farming by irrigation, rainwater run-offs and pesticide spraying.

WHAT type of chemicals are used?
WHEN are the chemicals applied; and
HOW are the chemicals applied?

Livestock could impact the pathogen levels in the shrimp ponds.

Livestock farms or sewage effluents can be a serious source of contamination by microbial pathogens (i.e. *Salmonella*, viruses, etc.). Shrimp farms need to be located away from any of these activities to decrease the chances of potential contamination. Again the farmer needs to learn –

WHAT type of contamination could flow from the livestock?
WHEN is the livestock operation most active; and
HOW could the contaminates reach the shrimp ponds?

The answers to these questions may indicate how often a farmer may need to sample ponds for chemical and microbial residues. Normal processing or cooking does not always eliminate all potential chemical and microbial contaminants associated with any previous farm site use or farming location.

"Processing and cooking does not always eliminate potential chemical and microbial food hazards"

What type of chemical tests should a farmer conduct? When? How?

Most farmers and smaller farming operations are not expected to conduct their own chemical analysis of the pond soil, water or shrimp. These tests can be complicated, expensive and usually require special equipment and labs. Likewise, individual tests can be required for the large variety of chemical residues that could be present. The tests are usually run by a cooperating government lab or a private lab. In either lab, the tests must be conducted by recognized standard procedures. Farmers are not expected to know these types of tests, but they must question if the proper tests are being conducted according to official, recognized methods (see Support Topics: Regulatory Tolerances).

A reasonable approach is to first decide if a particular type of chemical could be present, then try to estimate the possibility that a residue could be in the water. This thought process and any evidence to support the conclusions should be documented. Evidence could be that –

- there are no agricultural activities near the shrimp ponds;
- there is no drainage or water connecting local agricultural activities to the shrimp ponds; or
- there is no chemical spraying near the shrimp ponds.

For most shrimp farms the conclusion would be that "there is no evidence to suspect potential hazardous chemicals in the pond waters or shrimp". If there is evidence, such as obvious drainage from agricultural lands or crop spraying near the ponds, then sample testing should be conducted for the water and shrimp. Sampling should be done as often as necessary, but at least once per shrimp crop. It is recommended initially to sample the water before shrimp growth to detect potential problems. A final sampling of the shrimp should be conducted prior to harvest. The actual time for sampling must allow 2 to 4 weeks for the test results depending on the analytical procedures and lab. The expense and aggravation of chemical testing is usually shared with the eventual processor. It is best to arrange government support through universities and local agencies.

What type of microbial tests should a farmer conduct? When? How?

As for chemical residues, there should first be evidence that microbial contamination is possible. The evidence should be documented regarding possible –

- contaminated water that could be entering the ponds from local rivers, lakes or other natural sources;
- drainage from a neighboring livestock operations into the shrimp ponds;
- livestock (pigs, cows, ducks, etc.) having access to the shrimp pond waters;
- human waste or sewage is reaching the shrimp ponds due to direct contact or drainage from an outhouse or local toilets, or
- human or animal defecation into or near the shrimp ponds.

Human waste (sewage) and animals, wild and domestic, are an important factor when reducing the microbial contamination in the estuaries and ponds.

If these situations are not evident, the farmer's conclusion may be that "there is no evidence to suspect potential microbial hazards in the pond waters or shrimp." Unfortunately, potential microbial contamination from natural sources (local rivers, pests and wildlife) are usually evident for many shrimp farming operations. Previous test results for shrimp farmed about the world support this conclusion. Controls to prevent this natural contamination are difficult. For these reasons, sampling for microbial tests is recommended.

Sampling is recommended as often as necessary based on the evidence, but at least once per shrimp crop. Sampling should be conducted before harvest. The test results usually require 2 to 10 days depending on the test procedures and lab. If the results indicate certain microbial contamination, the farmer and processor must consider corrective procedures. Resampling and testing are recommended to prove the corrections were effective.

Water

Why is the Pond Water Quality Important in Aquaculture?

The water quality in the aquaculture ponds plays an essential part in the health, quality and safety of the aquaculture products. Contaminated pond water could lead to death of the shrimp, stress to reduce growth, or residues in the edible portion of the shrimp that could lead to human illness. The source of water used should always be questioned. The fresh and more brackish water sources (rivers, wells, neighboring ponds, etc) are usually more suspect because they are subject to contamination from the surrounding land and developments. If the quality of the water is suspect, farmers should consider methods to control the amount of chemical and microbial contamination. Options can include the amount and frequency of water exchanges or possible closed-cultures. The costs and consequences of these methods could influence the success of the farm.

Grounds

How can the grounds around the shrimp ponds affect product safety?

Good maintenance of the farm grounds can help reduce or eliminate multiple problems, some economically related and some safety related. By keeping plants around the ponds (i.e. mangroves) farmers can reduce erosion that could carry chemical and microbial contaminates to the pond. At the same time it is necessary to keep the grounds clean of high, excessive weeds, and trash and debris that can attract pests.

- Erosion can carry chemical and microbial contamination
- Weeds, trash and debris can attract harmful pests.

How can pests affect the safety of the shrimp?

It is a great challenge for the farmer to develop effective controls for wild animals on the farm. Unfortunately, rodents (rat, mice, nutria), birds (ducks and cormorants), and other wild animals can be a source of microbial contamination (i.e. *Salmonella*). Seasonal flying species, like ducks or seagulls, or land animals like rats need to be restricted from coming in contact with the ponds, feed or shrimp. As they defecate in or around the ponds or in the storage areas, the microbial contaminants can get in the water and feeds and eventually into the shrimp. These contaminations could be carried through the processing and handling steps and consequently could cause illness in consumers. Rodents are carriers of disease causing organisms and if not controlled properly, they could contaminate the feeds. Rodent control around the storage areas and preparation areas is essential. Birds can carry microbial concerns to the pond as well as cause an economic problem due to the predation of the shrimp in the ponds. Traditionally, birds have been controlled by placing nets or wires over small ponds or by using loud noises or dogs for larger ponds. Note, if dogs are used they could be a sources of fecal material introducing microbial contamination to the ponds.

Trash/solid wastes can attract rodent

How to control rodents and similar pests on the grounds?

The incidence of rodents on the farm can be reduced by a two-step approach:

1. **Eliminate the attraction to food and shelter**. All areas surrounding the storage areas and processing areas need to be freed of trash, debris, water puddles, high weeds and vegetation. At the same time, all storage and processing areas need to be cleaned regularly, and all trash and spills need to be cleaned promptly. Feeds need to be protected and securely packaged.

2. **Use a pest control program**. Traps and bait systems or fumigation programs can be used throughout the surroundings of the buildings, always being careful that they do not become an attractant or a contamination source to the feed or the product. Traps or fumigation activities should not be placed or conducted on or near shrimp products, packaging materials, feed or utensils used during harvest or handling or the shrimp. Be extremely aware that these chemicals, if not properly used and stored, they could become a source of contamination for the aquaculture animals and even lethal for the applicator. Pest control chemicals needs to be:

   - purchased from reputable dealers
   - properly labeled; and
   - used in the proper manner

Recommended Labeling for Chemicals

Original Container Label should include:

- Manufacturer / Distributor's Name
- Manufacturer / Distributor's Address
- Compound (Active Ingredients)
- Usage Instructions
- Disposal Instructions

Working Container Label should include:

- Compound (Active Ingredients)
- Usage Instructions

Hygienic Practices

Hygienic practices on the shrimp farm involve controls for potential microbial pathogens from human activities or from use of animal wastes (manure) as fertilizer. The major concern is that waste materials or fecal matter from mammals or warm-blooded animals can carry potential hazardous microbial pathogens.

Potential Microbial Pathogens from Human and Animal Wastes		
Type	**Possible Illnesses**	**Source**
Salmonella	Gastroenteritis	Human, animal, bird and reptile manure
E. coli	Gastroenteritis	Human, animal, bird and reptile manure
Virus	Gastroenteritis	Human manure

How can farmers control human waste problems?

Good hygienic practices in the pond area can minimize fecal contamination of the water at the pond site. Farm personnel should not be allowed to defecate in the estuary, ponds, on the ground near the estuary or ponds, or anywhere that rain would wash the feces into the estuary or ponds. To control fecal pollution in remote areas without toilets, plumbing or clean running water human wastes should be handled in a way so as to prevent leakage into or contact with pond water. This can be accomplished by allowing defecation in designated receptacles (i.e. plastic buckets), latrines, or field toilets that are subsequently treated with disinfectant (lime or chlorine) and routinely disposed of in a sanitary manner. Sanitary facilities should be located away from ponds or source water, and should be routinely maintained to prevent potential leakage into ponds or source water. Another way to dispose of disinfected human waste is to burn the excrement in a designated burning receptacle.

Can farmers fertilize the ponds with organic materials (manure)?

Although it is not recommended, some old farming methods have used organic fertilizers in the ponds during pond preparation and after ponds have been seeded with shrimp to promote natural foods. These practices can have adverse consequences on the quality and safety of the shrimp. For example, the use of untreated or improperly cured manure can become a source of microbial pathogens. The use of manure as fertilizer during the preparation of the ponds should be minimized. At the same time, over use of fertilizers can produce too much algae reducing the dissolve oxygen in the water and producing off-flavors in the shrimp.

> *"The use of manure as fertilizer during the preparation of the ponds should be minimized"*

Feed Care

Feeds used to raise shrimp can also cause potential food safety problems for consumers. The causes can be indirect by attraction of pests to the farm or directly through ingredients in the formulated feed transmitted to the shrimp (see Therapeutic Agents).

How should I store the feed?

Feeds need to be stored in dry and cool areas to extend their shelf life. Storing the product in a wet environment could result in mold formation and could even develop toxic substances. Never use feeds that are molded. If the feed is stored under extreme heat or direct exposure to the sun, the nutritional quality can be reduced. Feeds containing a therapeutic agent need to be stored well marked and separated from regular feed.

- Never accepts feeds that look mishandled, wet or old.
- Feeds should be properly labeled or identified.
- Store clean, dry, shaded, cool, and protected from pests.
- Do not store feeds near or in possible contact with pesticides, herbicides, fertilizers or fuels.
- Follow the “first in and first out” rule, to avoid problems with old feeds. Keep accurate inventory control, and always keep the new feed separated from the older ones.
- Separate regular and medicated feed (therapeutic agents).

Therapeutic Agents

Therapeutic agents are used in shrimp and fish farming. Uses range from sex selection to the reduction or elimination of illnesses in the animals. The application of these medicinals or therapeutants needs to be limited to extreme situations that cannot be controlled any other way. Abusive use of these compounds could result in the selective promotion of drug resistant strains of microorganisms. Therapeutic agents should only be use by trained individuals following the manufacturer’s instructions and withdrawal times. Misuse could produce an unsafe shrimp for human consumption. The potential problems associated with the use of therapeutic agents include the following:

- Allergic reactions
- Toxic effects
- Change in bacterial colonization patterns in the human-gut flora
- Development of drug resistant strains of microbial pathogens

How should farmers handle therapeutic agents?

Careful handling of these agents during application, dosage, withdrawal time, storage and disposal is extremely important to reduce the negative impact on the treated animals, farm personnel, environment and consumers. All therapeutic agents used should be recorded. An example of **Therapeutic Agents Application Record** is designed to provide information and guidance in order to assure proper withdrawal times. This record can also aid in the investigation of potential problems.

Application of therapeutic agents is administered to shrimp either through the feeds or in the water. Certain restrictions apply depending on the drugs to be used. Always follow the recommended application levels and the withdrawal times. High levels of therapeutic agents can cause irritation or death in the animal or cause off-flavors. Maintain accurate records of application dates, levels and reasons why it was used. Over use of therapeutic agents could lead to development of resistant strains of diseases and could also result in chemical residues in the edible portion of the animals. Strict control and records are needed when applying prescribed therapeutic agents.

Dosages should depend on the manufacturer's recommended usage levels and the method of application. Read and understand the product label.

Withdrawal time should be specified for all therapeutic agents. This is the time, usually in number of days, allowed to eliminate or reduce residuals in the shrimp. The withdrawal times will assure that the levels in the shrimp are within the permissible tolerances. New approved animal drugs have determined the proper withdrawal times for the recommended application. Withdrawal times are expressed in days beginning 24 hrs from application. Withdrawal times normally range from 7 to 10 days after last application.

Storage, handling and disposal of the drugs or feeds contain drugs should follow the manufacturer's directions. Do not use drugs unless they come with appropriate instructions and labels. Properly designed labels will give you instructions on how to store, mix, apply and dispose of the product. Always store the product separated from food, food contact surfaces, food utensils or food packaging. Only trained personnel should handle these products. Discard all unlabeled containers. Therapeutic agents or feeds with therapeutic agents must be relabeled if they are removed from the original .

What therapeutic agents are approved for use with farmed shrimp?

In the United States, the Food and Drug Administration classifies therapeutic agents into three main categories: 1) approved new animal drugs, 2) unapproved animal drugs of low regulatory priority, and 3) investigational new animal drugs.

Approved New Animal Drugs are the compounds that have been approved by FDA for use in aquaculture of species intended for human consumption. For Penaeid shrimp the only new approved animal drug is Formalin (Parasite-S by Western Chemical, Inc.) used to control protozoan parasites. The withdrawal time recommended is 10 days from the application.

Unapproved New Animal Drugs of Low Regulatory Priority are not specifically approved for aquacultural use and have not been associated with safety problems. No regulatory action is likely if the chemicals used have an appropriate grade or quality, they are used at the prescribed levels, according to good management practices, and they are not likely to have an adverse effect on the environment. Examples of this type of drugs are: Acetic acid (1000-2000 ppm), Calcium chloride (up to 150 ppm in water for fish transport), Garlic (whole to control sea lice), Hydrogen peroxide (250-500 mg/L to control fungi), Magnesium sulfate (to treat monogenic trematode), and Ice (for live fish transport). Although this listing is limited and contains materials not commonly used with shrimp, it is the only approved listing. Note, farmers should always check for the chemicals allowed in the country buying the shrimp. Lists approved in the country of production or farming do not always agree with lists for the country buying the shrimp.

Farmers should always check for the chemicals allowed in the country buying the shrimp. Lists approved in the country of production or farming do not always agree with lists for the country buying the shrimp.

What are Investigational New Animal Drugs (INAD)?

Investigational New Animal Drugs are drugs that are used under an investigational permit. FDA and CVM grant the exemption permits and must be in accordance with local and state regulations. This practice is usually restricted to operations in the United States.

What are extra-label drugs?

In the United States, aquaculture farmers encounter diseases for which there are no approved therapeutic drugs. In these cases, a licensed veterinarian can, under predefined criteria, prescribe and use certain licensed products. This practice, based on veterinarian approval, is called extra-label use.

Therapeutic Agents Application Record

Farm Name:_____ Location:_____

Pond Number	Shrimp Illness	Therapeutic Agent Used	Application Method	Dosage	Withdrawal Time (Days)	First Application date / time	Last Application date / time	Applicator (Person)	Harvest Date

Feed / Weight Control Record

Pond Number:_____ Seeding Date:_____

Harvest Date:_____

Farm Name:_____ Farm Location:_____

Feed type						
Day	Month	Month	Month	Month	Month	Month
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
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30						
31						

Product Evaluations

All farmers routinely monitor the size, amount and condition of their shrimp during production or pond grow-out. These routine checks can also be an excellent time to judge the quality and safety of the shrimp. It is strongly recommended that a pre-harvest check should be conducted to determine if the shrimp meet standards for product quality and safety. Once the shrimp are harvested, there is not much the farmer or processor can do to fix certain quality and safety problems. If the shrimp do not meet the standards, corrective measures applied at the ponds could help reduce the problem.

When the best time to sample the pond for shrimp evaluations?

Only ponds with acceptable odors and flavor should be harvested. Since is difficult to eliminate certain natural off-flavors after harvest, shrimp should be maintained in the ponds until off-flavors are purged. Shrimp farmers may be able to eliminate certain algae that cause the off-flavor by increasing water pH. This has been accomplished by carefully applying lime. This treatment should be gradually done for 3 to 5 days until the increase in pH eliminates the algae. Another pond management practice is to increase the water exchange and oxygenation with agitators. Another sample must be taken to determine if the corrections are effective.

How should a farmer collect pre-harvest samples for evaluation?

Live shrimp samples (2 to 3 pounds) should be collected from different locations in the pond with a clean seine or cast net in a manner that does not drag the shrimp through pond mud or the dirt bank. The samples should be combined in a sterile container. Careful handling is necessary to prevent contamination of the samples. The sample should be transferred without debris or mud from the pond. This sample should be handled by workers with clean hands. The container should be placed immediately on ice for delivery for microbial analysis at the processing plant or designated lab. The container should be surrounded with enough ice to maintain the sample below 35°F until it is removed for testing. If plastic bags are used, the shrimp should not puncture the bag and should not come in contact with the ice or melt water. This sample must be sent to the lab within less than 24 hours after taking the sample.

Pre-harvest sample collection

Pre-harvest sample ice storage for transportation

One portion of the sample will be used for microbial analysis. The remaining portion should be used for **quality evaluations** such as shell condition, texture, color and flavors. These quality measures can also be conducted pond side as well as at a processing lab with facilities to properly cook the shrimp for flavor and odor tests. If the evaluations are conduct a distance from the pond site, the samples should be placed and transported in a container similar to that used for the microbial sample.

How are the evaluations conducted and problems corrected?

The quality and safety evaluations must be conducted in less than 24 hours after the sample is collected. All evaluation results should be recorded in a **Pre-Harvest Evaluation Record** at the farm/pond site or in the processing lab.

Pre-harvest **microbial testing** should screen for potential *Salmonella* based on a standard microbial procedure that requires lab facilities (see Microbial Concerns for Farmed Shrimp). The standard procedures may require 4 to 7 days to complete. In some cases, more rapid, unofficial tests can be used to provide a quicker, but less accurate measure for *Salmonella*. If the shrimp test negative (no *Salmonella* detected), then the shrimp can be harvested. If the shrimp test positive for *Salmonella*, then corrective options should be considered to reduce or eliminate the *Salmonella* from the shrimp. Since the pond water is generally considered to be the *Salmonella* source, water exchange in the pond may reduce or eliminate the organisms from the pond and/or the shrimp. If water exchange is unsuccessful, the farmer may need to work with the processor to either sell the shrimp in a market where *Salmonella* is acceptable in the raw product or to further process the product to reduce or eliminate the *Salmonella*. Further processing of the product may include heading, peeling, and deveining with subsequent antimicrobial treatments, mild treatment, complete cooking, or value-added processing with a final cook step. It is recommended that final product testing for *Salmonella* should be conducted when any of these further processing options are used to make sure the *Salmonella* has been eliminated from the product.

Shell condition and texture is determined by feeling the shell surface and strength, and trying to hand peel the shell from the raw shrimp. Soft shells due to recent shedding or possible diseases should be avoided. Only ponds with less than 5% soft shells should be harvested. If more than 5% of the pond has soft shells, the farmer should wait a few days until the shells harden.

Shrimp flavors and odors are best judged with cooked shrimp. Boiling shrimp in a sealed plastic bag is recommended to capture the odors released during cooking. A new, clean bag with whole shrimp (approx. ¼ pound or 250 grams) can be placed directly in boiling water for about 1 to 3 minutes to assure an effective cook. Make sure the shrimp do not pierce the bag causing leakage. The odors will be obvious when the bag is carefully opened. Further odor judgments should be conducted after breaking segments of

the cooked shrimp and shrimp heads for more direct nose evaluations. The odors are usually a better indication of potential problems than is the flavor.

Also, the samples should not be taking until appropriate recommended withdrawal times for all antibiotics used during production of the shrimp have been met. Therapeutic agent treatments used should be confirmed by referring to Therapeutic Agent Application Record. If appropriate recommended withdrawal times are not met, shrimp should be left in the pond until for the length of time necessary to meet required withdrawal times.

Pre-Harvest Product Evaluation Record

Pond #_____

	First Evaluation Date _____			***Second Evaluation (if needed) Date _____***			***Third Evaluation (if needed) Date _____***		
Parameter	**√ / X**	**Corrective Action(s)**	***Ready to Harvest (Yes/No)***	**√ / X**	**Corrective Action(s)**	***Ready to Harvest (Yes/No)***	**√ / X**	**Corrective Action(s)**	***Ready to Harvest (Yes/No)***
Shell Condition & Texture									
Flavor of the Head (Off-flavors)									
Flavor of the Body (Off-flavors)									
Salmonella in the Shrimp (Presence or Absence)									
Medicinals Application Control Check									

√=Acceptable X=Unacceptable

HARVEST CONTROLS

The farm-raised shrimp harvesting operations involve a number of steps that could influence the final product quality and safety. The key steps are Reduced Feeding; Preparing Equipment, Supplies and Workers; actual Harvesting; and Product Handling and Transport. Farmers must consider proper procedures at each step to reduce bacterial contamination and prevent product discolorations.

After the processing plant approves harvest, what does the farmer need to do to assure quality and safety of the shrimp?

- **REDUCE FEEDING:** Feeding should be stopped at least 48 hrs before harvesting. This will reduce the development of off-colors in the head of the shrimp known as 'red head'. The discoloration is due to food digesting in the gut (cephalothorax segment) of the shrimp. This discoloration is not a food safety or edible quality problem, but buyers have considered it to be a product defect.

- **PREPARE EQUIPMENT, SUPPLIES and WORKERS:** If not available on pond site, farmers should confirm that either the processing plant or product buyer is going to send enough clean potable water, clean ice, and clean containers to collect the product. As a general rule, farmers must have two pounds of ice per every pound of shrimp to be harvested or at least a pound of ice per pound of shrimp to be harvested. This will prevent spoilage problems due to lack of ice.

<u>RECOMMENDATION</u>

"Prefer 2 parts ice per 1 part shrimp on a weight basis"

If not available on pond site, farmers should confirm that either the processing plant or product buyer would send enough blackspot controls, sanitizing compounds and clean potable water to treat the shrimp at harvest. The amount of material needed will be based on the amount of shrimp expected to be harvested, plus some extra in case of unexpected problems or more shrimp. It is MOST important that enough clean water (<u>not</u> pond or river water) is available to prepare the shrimp treatment solutions and washes (see Melanosis and Chlorination).

Clean water should comply with the chemical and microbiological contaminant levels specified by the regional authorities. These standards should be equivalent to the international drinking water standards specified by FAO/WHO.

Although the actual harvesting can be a dirty operation, the equipment used to catch the shrimp should be cleaned to remove debris and previous dead shrimp that could contaminate the new shrimp. All baskets, tubs or bins for handling and transporting the shrimp should be properly cleaned and sanitized. A 4-step cleaning procedure recommends:

1. Wash with detergent
2. Rinse with clean water
3. Sanitize with 200 ppm chlorine
4. Final rinse with clean water before use

All employees that are scheduled to work during the harvest must be in good health and have no infected cuts on their hands. The best rule is to avoid any hand contact with the harvested shrimp.

How does the product need to be handled during and after harvest?

- **HARVEST:** On most farms the shrimp is harvested with a net or bag that catches the shrimp as the pond is drained. This process must be done with some care to prevent damage to the shrimp or excessive accumulation of mud and debris with the shrimp. The bag should be emptied into clean baskets, tubs or bins approximately every 15 to 20 minutes. Regardless of the amount harvested, the temporary storage containers should weigh no more than 50 to 60 pounds per container to allow for reasonable handling.

  The temporary storage containers should be treated on the farm to prevent development of black spot (melanosis) and to reduce potential pathogenic bacteria. The black spot treatments (bisulfites or Everfresh) are more effective if they are applied immediately after harvest, even while the shrimp are alive. Likewise, if there are concerns for any potential pathogenic bacteria such as *Salmonella*, anti-microbial treatments to reduce these pathogens (i.e., chlorination washes) should be applied at the farm to help prevent carrying these bacteria to the processing plant. The sequence and methods for treatment will depend on the particular shrimp and different farming locations. Farmers and processors must determine the best treatment options mindful that some anti-microbial treatments could influence the effectiveness of the melanosis treatment. Regardless of which treatments are used, they must be applied using clean potable water.

"Regardless of which shrimp treatments are used, they must be applied using clean water"

- **PRODUCT HANDLING and TRANPORT:** The final ice packing of the shrimp for transport should assure proper chilling without damaging the shrimp. Shrimp packed in ice alone should be packed by layering. A layer of ice should be placed on the bottom of the tote followed by a layer of shrimp and then a layer of ice and so on. When the tote has been fully packed a final layer if ice should be placed on the top to maximize the cooling effect. When an ice slush is used, the shrimp and ice slush should be thoroughly mixed to eliminate any large pockets of shrimp from forming in the tote. Again, a final layer of ice on top of the packed tote will maximize the cooling effect.

  Shrimp that does not get harvested by draining the pond should never be mixed with the harvested shrimp. The shrimp that stayed behind could be shrimp of lower quality that if mixed with the other shrimp reduces the total value of the entire lot. This leftover or hand harvested shrimp needs to be placed in separate bins that are labeled as "handpicked" shrimp. This shrimp should be segregated and properly identified for further evaluation by the processing plant.

"Shrimp must be sent to the processing plant as soon as possible"

Other Considerations:

- Product should be monitored to avoid chemical contamination from generators, trucks, etc. used during the harvest.

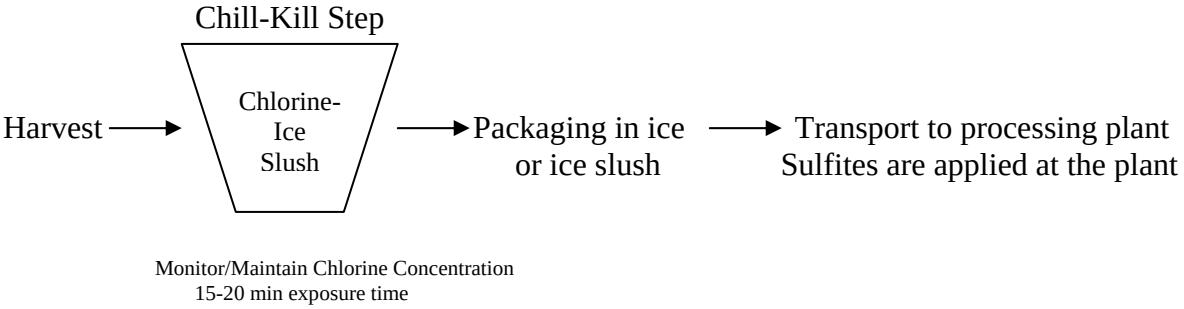
- Farmers should try to reduce pests and insects during the harvest that could otherwise cause filth contamination.

- The bins or container designated to transport shrimp from the farm to the processing plant should never be placed in contact with the grounds.

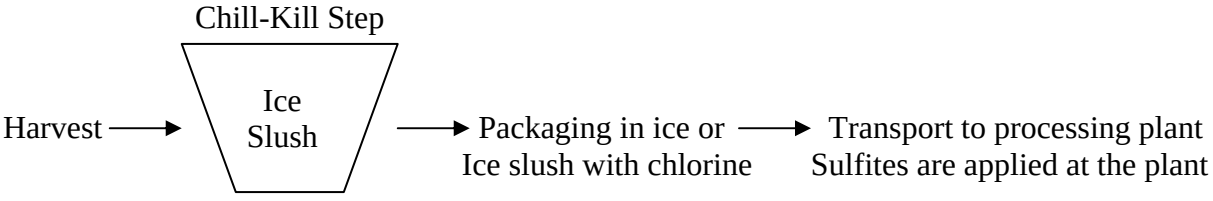
What are the recommended methods for use of chlorine and melanosis treatments?
Proper and careful use of chlorine and melanosis treatments is necessary to achieve the recognized and necessary benefits of these chemical aids. There is no single method for application. The methods for use will vary depending on the situations at the farm and processing locations, and the type of product to be processed. The best option will depend on experience with the farm and the processor.

Options for product to be headless/shell-on or peeled (options A & B)
Note, these options assume the harvest operation is located close to the processing operation such that there are no delays in the delivery of the fresh shrimp. If the harvested shrimp is delayed in transport to the processing plant, the application of sulfites should be arranged near the harvesting operation.

A. If more aggressive bacterial controls necessary immediately after harvest



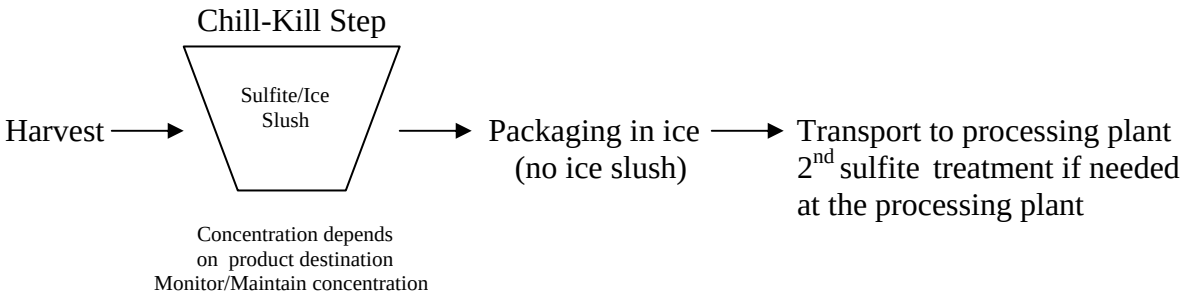
B. If mild bacterial controls that may be necessary after harvest

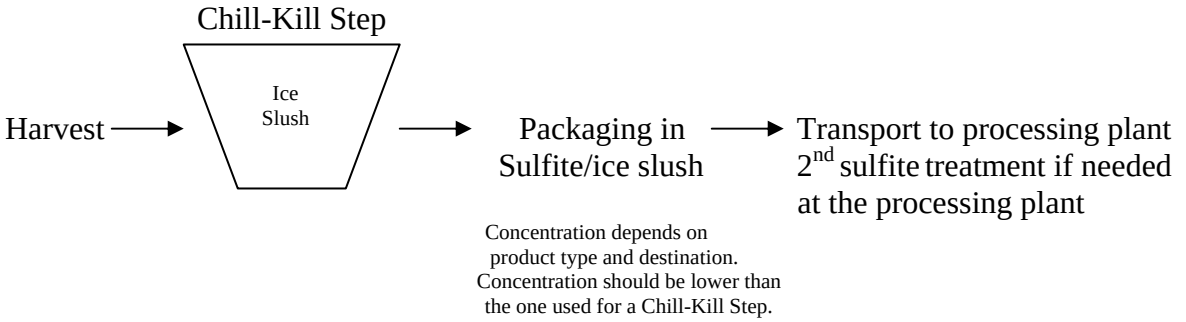


Options for product to be processed for Head-on (whole) shrimp (options C & D).

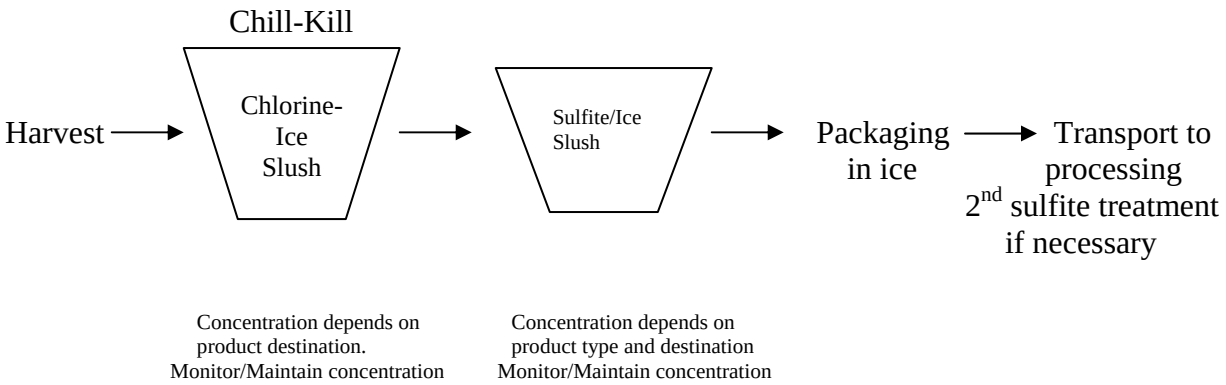
More immediate and extra melanosis treatment is necessary to control black-spot development in the head of the shrimp. The head contains the enzyme that cause blackspot and the higher oxygen levels that promote rapid development of blackspot.

C. If more immediate application of sulfite controls is necessary and bacteria is not a problem





D. If bacterial and melanosis controls are necessary immediately after harvest



Extra Considerations:

Experience with a particular shrimp and farm situation will determine the best combination of dipping times and concentrations to prevent melanosis and reduce bacteria. These treatments are most effective when applied immediately after harvest, even while the shrimp are alive. Often dips are repeated at the processing plant to assure effective treatments. Likewise, there must be a balance between the melanosis and sanitizing treatments. Chlorine and melanosis controls should not be combined in the same treatment. Draining and rinsing is recommended between treatments with chlorine and melanosis controls. The chlorine will reduce the influence of the melanosis controls. The farmer and processor must learn the best combination of dips to remain effective without leaving excessive sulfite residuals on the shrimp. Excessive treatments can also flavor or discolor the shrimp.

All solutions should be prepared with clean potable water. The solutions should completely cover the entire basket of shrimp. Mild agitation helps mix the solutions about all the shrimp.

For some farmed shrimp, the concern for potential pathogenic bacteria calls for an initial antimicrobial treatment with a mild iced chlorine solution. The thought is that this treatment is more effective if the shrimp actively 'drink' the solution to kill any internal bacteria. Following this sanitizing treatment, the shrimp should be washed with clean potable water, before treating for blackspots with sulfites.

To prevent melanosis, shrimp should be immediately washed in a 1.25% bath of sulfite solution (see Melanosis - Sulfites). Treatment time depends if the product have been washed to remove excessive mud and debris prior to dipping, and also if the product has been chilled. Although a freshwater pre-rinse could kill some of the shrimp, mud and debris can reduce the effectiveness of the sulfite dip. In general, cleaned shrimp treated with this concentration for 1 to 3 minutes, have a residual level of 100 ppm. If then product is going to be packaged as head-on or if the shrimp have not been pre-washed, a higher concentration and a longer exposure time are necessary. In some situations, the farmer or processor may decide to keep the shrimp in an iced sulfite solution or slush for longer time or during transport to the processing plant. A 0.25% sulfites or less concentrated solution or should be used in this situation.

An Everfresh solution can be used to prevent blackspot if the processor wants to eliminate use of sulfites, but special care is necessary with Everfresh to assure a more immediate application before the shrimp begin to die (SUPPORT TOPICS: Melanosis – Everfresh). Keep in mind that Everfresh cannot be used in chlorinated water.

Product Defects

What quality problems can result from mishandling at the farm?

Appearance Defects **in alphabetical order:**

•**Blackspots or Melanosis:** Melanosis is a natural chemical reaction that occurs in shrimp and results in a brown, dark green to black discoloration. It is not of safety concern. It is primarily a cosmetic or appearance problem resulting from natural chemical reactions uniquely related to the shell and molting cycle of the shrimp. It begins to occur first on the shell, and if allowed to progress will taint the surface of the meat. Lots with severe melanosis will be rejected or devalued. Shrimp with blackspots should be removed in the culling step while processing. If melanosis problems persist, the processing plant and farm should evaluate the blackspots control plan.

Preventive Measures: Blackspots can be controlled or prevented by using sodium bisulfite, sodium metabisulfite or Everfresh (4-hexylresorcinol). Reducing exposure to sunlight and immediately icing the products reduces the chance of developing of blackspots.

•**Broken & Damaged**: Any shrimp that is crushed, mutilated, cut or missing a body segment or tail fins can be considered broken or damaged.
Preventive Measures: Careful handling, use of a proper shrimp to ice ratio, and careful packaging are necessary to prevent this problem during transport.

• **Discoloration due to Heat Abuse**: This condition is caused by abusive exposure to heat. If shrimp are not properly iced after harvest on the farm, they will actually begin to look cook. The rise in temperature will promote bacterial growth leading to decomposition. Pink discoloration most often occurs along the dorsal edge (top of back), ventral extremities (bottom side and swimmerets) and the tail.

Preventive Measures: Maintaining the shrimp on ice at all times prevents this problem. It is best to harvest at night when there is no sunlight and the temperature is cooler. As a general rule, the total temperature exposure time of the harvest shrimp above 35°F should be no more than 30 minutes cumulative from time of harvest to icing. THIS GENERAL RECOMMENDATION IS NOT A REGULATORY REQUIREMENT.

<u>RECOMMENDATION</u>
"Less than 30 minute above 35 ℉ at harvest"

•**Loose heads:** This condition occurs when the shrimp heads (cephalothorax) have been separated from the body of the shrimp. This problem is due to either enzyme activity or by poor handling of the shrimp. It is a sign of mishandling and temperature abuse of the shrimp.
Preventive Measures*:* Proper cooling with clean ice and transporting the shrimp in properly packed ice bins can help prevent this problem.

•**Milky Shrimp**: Shrimp with white, milky meat appearance is known as 'milky shrimp'. It is caused by a natural microscopic parasite infection, which is not a food safety problem, but does degrade the product value.
Preventive Measures: Shrimp showing this problem should be rejected during a culling step while processing.

•**Mixed Species:** Color of the shrimp should be uniform within the package. Mixed colors usually indicate mixed species, some of which may be of inferior quality or type. It could result due to differences in shrimp from different ponds or different farms.
Preventive Measures: This defect applies only to farms with direct sales. Appropriate and careful separation of shrimp by species and sources can prevent this problem.

•**Pitted or Gritty Shells:** In some cases a sandpaper feel on the shrimp shell can be caused when sodium bisulfite or metabisulfite is not dissolved in water before application to shrimp. In excessive amounts, this additive can pit and corrode the shells.
Preventive Measures: Proper application involves dissolving the sodium bisulfite or metabisulfite first in the water and then immersion of the shrimp in the treatment solution. Never simply powder the sodium bisulfite or metabisulfite on the shrimp or about the ice used to package the shrimp. A powder application can cause pitting and usually results in an uneven treatment for melanosis.

•**Red Heads:** When shrimp are harvested with feed in the digestive system a red color develops inside the cephalothorax. Other colors can develop depending on the shrimp diet. This is not a quality or safety issue, but buyers might perceive it as an appearance problem.
Preventive Measures: The problem can be reduced by stopping of feed at least 48 hrs before the harvest.

•**Soft Shell:**

This is a natural condition that could be considered a defect if product is to be sold shell-on or whole.
Preventive Measures: Farmers should monitor molting cycles and only harvest when 5% or less of the harvest has soft shell.

•**Yellowing:** This discoloration can be caused by abusive use of sodium bisulfite. Indications of this are unusual yellowing of the underside of shrimp (swimmerets, tail, etc), as well as, a bleached appearance.
Preventive Measures: Maintaining the appropriate concentration of sodium metabisulfite in solution and proper product exposure time can prevent this problem.

Odor / Flavor Defects *in alphabetical order*

•**Odors of Decomposition:** Objectionable, off-odors are usually due to bacteria spoilage.
***Preventive Measures*:** Proper icing and temperature controls.

•**Chlorine or Chemical smell:** Condition that can result when shrimp are washed and sanitized with a very concentrated solution of chlorine. Chlorine may also be used to mask smells in shrimp of inferior quality. The FDA does not accept presence of this smell.
***Preventive Measures*:** Monitoring amounts of chlorine in water and appropriate exposure times.

•**Choclo and Earthy Odors**: Certain algae blooms within the ponds can cause this off-odor. Once harvested, the processor cannot eliminate this unacceptable odor.
Preventive Measures: Common practice indicates that the best way to deal with these is by sensory evaluation of the shrimp before harvest. If present, the shrimp farmer may eliminate the algae by water exchanges and/or increasing pH of the water with liming agents. The shrimp will purge off flavor and then it will be ready for harvest. The FDA does not accept presence of this smell since it is not characteristic of the shrimp and suggest decomposition.

• **Off flavor in the head:** Objectionable flavor that can result from initial spoilage or previous use of certain feeds. This defect impacts the product when it is intended for head-on commerce. Sensory evaluation needs to be performed on shrimp before harvesting.

•**Petro-Chemical Smell:** Minimal exposure of shrimp to diesel or oil by direct contact or indirectly by fumes can impart a chemical smell to the shrimp.
Preventive Measures: Monitoring of chemicals to prevent potential contamination during harvest will prevent this problem.

Texture Defects *in alphabetical order*

•**Mushy or Soft Texture Shrimp:**
Occur when excessive quantities of ice are placed on shrimp resulting in crushing of the product. Soft texture can also result from decomposition.
Preventive measures: Storing shrimp in at least 1 to 1 weight ratio for shrimp and ice. A 1 to 2 ratios of shrimp to ice is preferred.

SUPPORT TOPICS

MICROBIAL CONCERNS FOR FARM-RAISED SHRIMP

Bacteria and viruses are the microbial concerns associated with most seafood, including farmed shrimp. They are too small to be seen without a microscope and they are widespread throughout our environment, on our foods, and inside and on our bodies. By far, bacteria are the most common food problem, both in terms of food spoilage and contamination. Viruses can also contaminate seafood and certain varieties can harm the health and growth of farmed shrimp. Basic knowledge of these microbial concerns is essential to developing and maintaining controls to prevent food quality and food safety problems.

What are bacteria?

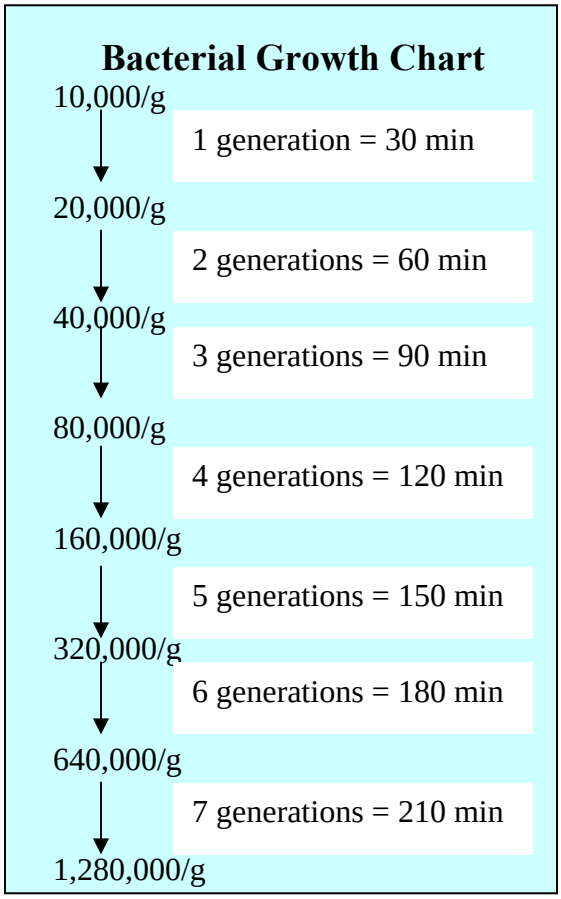
Bacteria are living single cell, microscopic organisms that thrive as numerous shapes and types. Relative to foods, they can be classified into two main groups – spoilage and pathogenic bacteria. The **spoilage bacteria** include types that cause foods to develop bad odors and off-flavors leading to eventual product decomposition and market rejection. The spoilage types can be further classified according to the temperature range that they can grow to cause spoilage. For examples, bacteria that grow and spoil farm-raised shrimp at refrigeration (cool) temperatures (0-15°C) primarily consist of *Shewanella putrefaciens* and *Pseudomonas* spp. Microorganisms that grow and spoil farm-raised shrimp at warm temperatures (>15°C) tend to be dominated by *Vibrio* species.

Common Bacteria Associated with Shrimp	
Spoilage Bacteria	Pathogenic Bacteria
Shewanella putrefaciens	*Salmonella*
Vibrio	*V. cholerea*
Pseudomonas	Other Fecal Pathogens

Pathogenic bacteria are those that can cause human illnesses. They include common names like *Salmonella, Vibrio cholera, E.coli, coliforms*, and *Listeria monocytogenes.* By far, *Salmonella* is the primary microbial pathogen of concern for farmed raised shrimp. This concern is not based on actual human illnesses that have resulted from contaminated shrimp, but rather certain regulations that require a 'zero' tolerance or *Salmonella* free condition for shrimp products that are raw or cooked, and both fresh or frozen. The regulations consider the presence of *Salmonella* in shrimp and other fishery products is an indication for the lack of sanitary controls during production, harvest, and/or processing.

How do bacteria grow?

Bacteria grow by binary fission or simply splitting. This means that one bacterial cell divides into two cells, these two cells divide into four, four divide into eight, and so on. The time it takes one bacterial cell to divide into two cells is called the generation time. The shorter the generation time, the faster a bacterium grows. For example, if a shrimp has 10,000 cells per gram living on it and the generation time of the bacteria is 30 minutes the following situation can occur in warm temperatures.

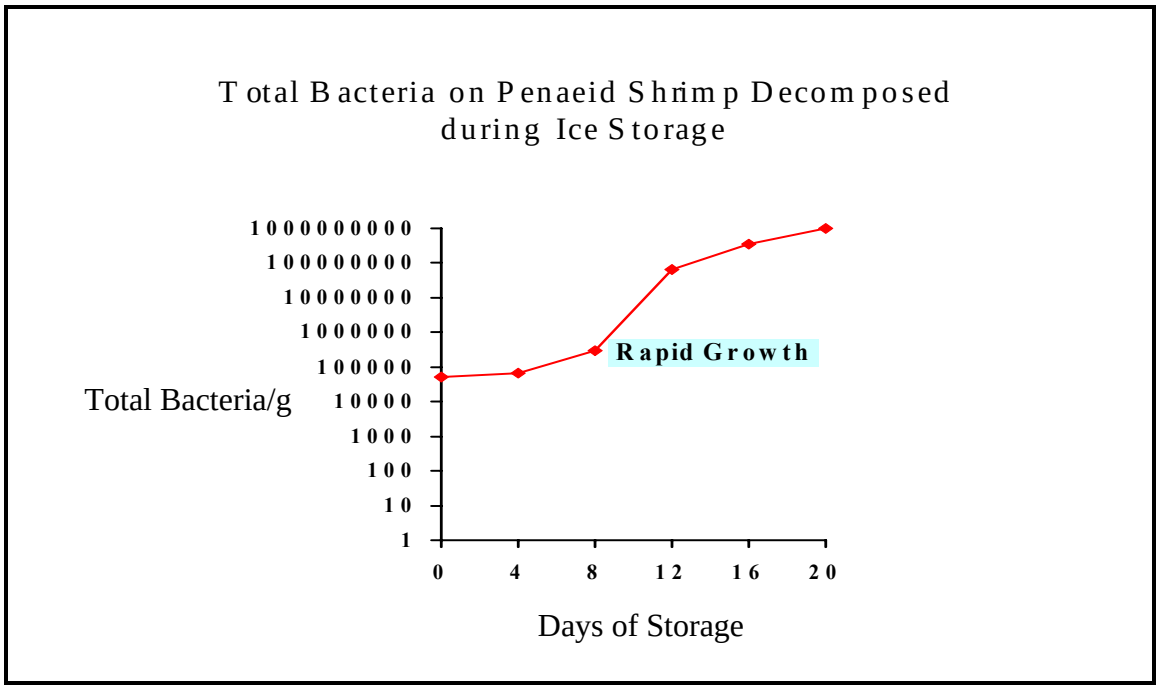


In this example, seven generations have occurred which took 30 minutes each resulting in the bacteria increasing from 10,000/g to 1,280,000/g. The total time necessary for this to happen was 7 x 30 minutes = 210 minutes or 3.5 hours.

What parameters affect bacterial growth?
Several factors affect bacterial growth on shrimp including:

a. initial amount and type of bacteria (microflora) on the shrimp;
b. available nutrients (food) for growth; and
c. temperature during handling and storage.

The numbers and types of bacteria initially present on the product and their particular growth requirements determine which bacteria will flourish on the product after harvest. Additionally, the nutrients for bacterial growth (i.e., energy source, water, minerals, etc.) are generally considered to be abundant on shrimp. Keeping in mind that microflora and ample growth nutrients are readily present on shrimp, the most important growth factor associated with producing safe, good quality shrimp is the temperature control. Basically, the greater the temperature and length of product exposure, the faster the bacteria will grow and spoil the product. In the previous example demonstrating bacterial growth by binary fission, we showed that 10,000 bacterial cells per gram increased to 1,280,000 cells per gram of shrimp in 3.5 hours when the conditions were such that the bacteria had a generation time of 30 minutes. If shrimp were stored at 36°C the bacteria on the shrimp would grow at approximately this rate. This rapid growth rate at warm temperatures like 36°C which promotes a 30-minute generation time. In contrast, if the shrimp were held at 0°C the generation time would be delayed to 41.1 hours. It takes approximately 12 days (288 hours) for bacteria on shrimp stored at 0°C (ice) to increase from 10,000 cells per gram to 1,280,000 cells per gram



How do we control bacteria associated with farm-raised shrimp (Pathogenic and Spoilage organisms)?

First, pathogenic bacteria associated with farm-raised shrimp are mainly controlled by maintaining good pond water quality. A source of pond water with limited concentrations of pathogens will minimize the probability of harvesting product contaminated with these organisms. Likewise, control of fecal contamination (human and animal waste) at the pond site helps prevent further contamination of the pond water. Additionally, concentrations of spoilage bacteria, fecal pathogens, and other pathogenic bacteria present on farm-raised shrimp can be minimized by reducing temperature exposure through the use of clean ice. Use of anti-microbial agents (i.e., chlorine rinses) to reduce any bacteria present is a final line of defense that can be applied during harvest and processing.

What are viruses?

Viruses are defined as submicroscopic pathogens composed essentially of a core of a single nucleic acid enclosed by a protein coat, able to replicate only within a living cell.

What viruses are important in farm-raised shrimp (Shrimp viral pathogens and Human viral pathogens)?

Two groups of viruses are of concern in farm-raised shrimp, shrimp pathogens and human pathogens. Shrimp viral pathogens, like Taura, Yellowhead, and White Spot are viruses that cause disease in the shrimp. These viruses do not cause disease in humans and are not food safety concerns.

Human viral pathogens are viruses that cause disease in humans. The viruses of concern in farm-raised shrimp from a food safety perspective are Hepatitis A and E and Norwalk-Like viruses. These viruses are generally associated with fecal contamination of the product resulting from polluted growing waters and poor hygienic practices from workers handling the product. Control of viral fecal pathogens is accomplished by maintaining good pond water quality and good hygienic practices.

SHRIMP DECOMPOSITION

What is decomposition?

Decomposition is a regulatory term used to describe or measure the advancing stages of food product spoilage. Decomposition is caused by initial bacterial breakdown of the food products and the additional chemical enzyme changes that contribute to further degradation of the product. These changes are noticed and described by abnormal odors, off-flavors, textural changes, and product discoloration.

How is decomposition measured (Sensory and Chemical)?

Measures for decomposition in shrimp are based on sensory and chemical analyses. The main parameter evaluated in sensory analyses is the odor of the shrimp. The odor of shrimp can be judged using a 3-Class system, which is described below.

- Class 1 – Passable
  Includes fishery products that range from very fresh to those that contain fishy odors or others characteristic of the commercial product, not definitely identifiable as decomposition.

- Class 2 – Decomposed (Slight but definite)
  Represents the first stage of definitely identifiable decomposition. An odor is present that, while not really intense, is persistent and readily perceptible to the experienced examiner as that of decomposition.

- Class 3 – Decomposed (Advanced)
  Possesses a strong odor of decomposition that is persistent, distinct, and unmistakable.

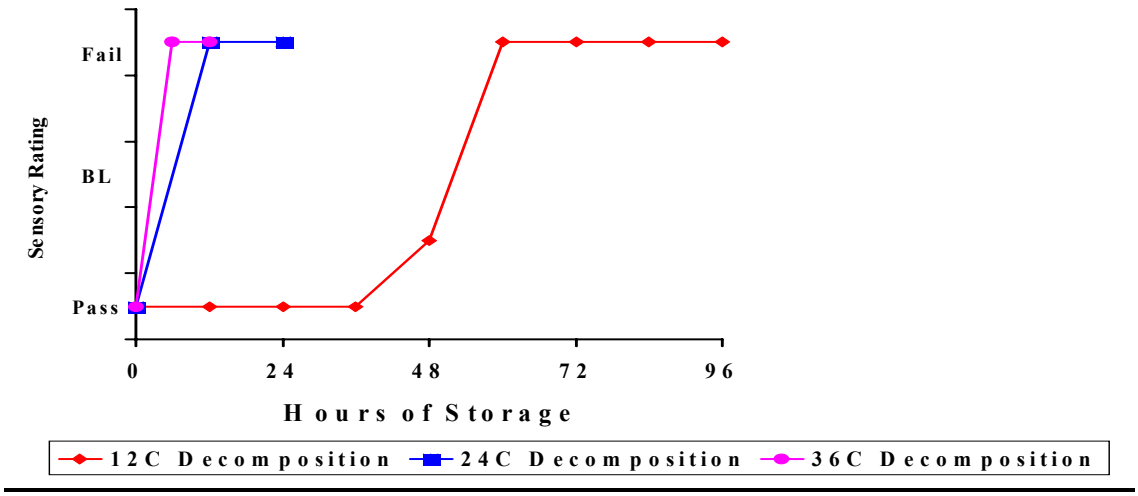
Decomposition is also measured by chemical analyses for compounds that are developed during progressive spoilage. Compounds that have been most useful for analyzing shrimp decomposition are putrescine, cadaverine, and indole. Indole at the 25-μg/100g level has traditionally been used by FDA for confirmation of sensory decomposition. More recent tests indicate that other chemical indicators like putrescine or cadaverine at selected concentrations may confirm sensory decomposition more accurately than indole. Research is in progress to better understand potential applications for these indicators in regulatory and industry settings.

How does temperature influence shrimp to decomposition?

The graph shows the progressive changes in sensory classification over time for farm-raised shrimp (*Litopenaeus vannamei*) decomposed at 12, 24 and 36°C. On the graph, the lowest section indicates passable product (Pass), the middle section indicates borderline product (BL), and the top section indicates failed product (Fail), Class 2 or greater.

The shrimp exposed to 12°C failed sensory analysis at hour 60, the shrimp held at 24°C failed sensory analysis at hour 12, and the shrimp held at 36°C failed sensory analysis at hour 6. Sensory decomposition increased much more rapidly in the shrimp decomposed at 24°C and 36°C than the shrimp decomposed at 12°C. Note, there is a similar period of rapid sensory decomposition accompanying the rapid growth period for bacterial.

Sensory Ratings for Penaeid Shrimp Decomposed at 12, 24, and 36°C



FILTH IN SHRIMP

What is filth in terms of farmed shrimp?

Filth is a regulatory term referring to dirt, debris and other undesirable materials that can become mixed with a food such as shrimp. These materials can include things such as wood splinters, sticks, stones, plant stems, mud, sand, rust, burlap bagging, cigarette butts, paint chips and other items that are not considered a typical or valued part of the food. Filth found in shrimp can include insects, insect parts or fragments, rodent hairs, feathers and other objectionable animal parts that can become mixed with the shrimp during harvest and processing.

What are some typical measures for filth or foreign matter?

Samples of fresh or frozen raw shrimp may be detained when a regulatory analysis results in the following levels:

- FLIES AND OTHER INSECTS (WHOLE OR EQUIVALENT)
  1. Disease-carrying insects-2 in a sample
  2. Other insects- 3 of the same species in a sample.

- INSECT FRAGMENTS
  1. Fragments from disease-carrying insects – 5 fragments (excluding set fragments are clearly identified as parts of a disease-carrying insect)
  2. Large body parts of disease-carrying insects (i.e. head, thorax, abdomen) –1 in at least 2 of 6 subs*.
- HAIRS
  1. Rat or Mouse-average of 1 per sub*, any size.
  2. Striated but not rat or mouse-Average of 4 per sub*, any size.

* sub samples are referred to as units within the original samples taken by the regulatory official.

These measures for filth are guidelines established by the FDA (Food & Drug Administration) in the United States. They are similar for authorities in Europe, Canada and other countries. Experts are trained to examine food products with direct eye observations or aided with microscopes. above guidance does not include all types of filth of different combinations of filth that may be found in shrimp. The filth guidelines are considered an indirect measure for previous handling conditions that were not sanitary and could have contributed to potential foodborne illnesses.

Can filth cause illnesses if eaten with the food?

All filth is undesirable in food and certain types can cause foodborne illnesses. Obviously paint chips, wood fragments and glass pieces can be harmful. Likewise, illnesses can be associated with certain disease carrying insects. Disease-carrying insects have all the following attributes:

- Wild populations known to carry *E. coli, Salmonella* and *Shigella*.
- Synanthropy (a preference to live in human settlements)
  1. Endophily (tendency to enter building)
  2. Communicative behavior (scaling between fifth and human food)
  3. Attraction to both human and excrement or other pathogen reservoirs.
  4. Recognition by medical entomological authorities as a disease-carrying species.

Examples include:

Flies

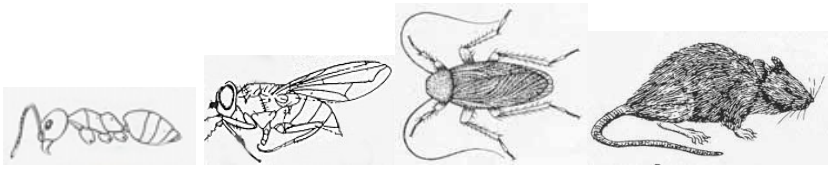
- Little house fly (*Fannia canicularies* (L.))
- Latrine fly (*Fannia scalaries* (F.))
- House fly (*Musca domestica* (L.))
- Stable fly (*Stomoxys calcitrans* (L.))
- Cosmpolitan Blue bottle fly (*Calliphora vicina (Robineau-Desvoidy)*)
- Holarctic blue bottle fly (*Calliphora vomitoria* (L.))
- Oriental latrine fly (*Chrysomya megacephala* (F.))
- Blue bottle fly (*Cynomyopsis cadaverina* (R.-D.))
- Secondary screwworm (*Cochliomyia macellaria* (F.))
- Green bottle fly (*Phaeniacia sericata* (Meigen)
- Black blow fly (*Phormia regina* (Meigen))
- Redtalied flesh fly (Sacrophaga haemorrhoidalis (Fallen)

Ants:

- Pharaoh ant (*Monomorium pharaonis* (L.))
- Thief ant (*Solenopsis molesta* (Say))

This is not necessarily a complete list of disease-carrying insects that might be found in shrimp.

Examples of Filth:



ANT **FLY** **COCKROACH** **MOUSE**

CHLORINATION FOR FARM-RAISED SHRIMP

The microbial controls and sanitizing benefits from use of chlorine compounds in are obvious and undisputed. It is widely used to maintain water safety all about the world. Likewise, these benefits are well known in handling shrimp and other foods. Chlorinated waters have been used during harvest to reduce the natural bacteria coming from the ponds, while additional treatments have been used during final processing. Chlorine is the most widely used sanitizer in seafood processing and possibly the least expensive, yet controls are necessary to prevent excessive use. Elevated concentrations and prolonged exposure times can damage shrimp by discoloration, addition of chemical odors, and causing poor surface texture. Likewise, misuse can contribute to corrosion of equipment and potential adverse by-products.

What types of chlorine compounds are used with shrimp?

There are 3 basic types of chlorine compounds that are used with farming and processing of shrimp and other seafood.

Gaseous chlorine (Cl_2), which comes in bottled cylinders, is more commonly used to treat the water used in the processing plant. Residual levels in the treated processing water can range about 1.0 ppm.
Liquid chlorine (sodium hypochlorite; NaOCl), which can be provided in concentrations ranging from 2 to 15%, is often referred to as 'bleach'.
NOTE: Before using a liquid bleach look at the label instructions to make sure this liquid form is approved for food use.
Powered chlorine (calcium hypochlorite; $Ca(OCl)_2$), which is 100% chlorine, can be dissolved in water to prepare various concentrations. The powered form is more commonly used on shrimp farms. **CAUTION:** The powder should be stored dry until used and should be handled very carefully to prevent hazardous eye contact.

How does chlorine work?

A chlorine solution can contain many effective chemicals with differing microbial killing power. The hypochlorous acid compound (HOCl) provides the most effective kill. All chlorine solutions contain HOCl, but the amount or effective killing power depends on the solution pH and temperature. A pH range of 6 to 7.5 is most effective. If the solution does not have the ability to maintain (buffering) this effective pH range, the microbial killing power will be significantly decreased. At pH values less than 5 the solution will become more corrosive, and at lower pH values the solution could release toxic chlorine gas (muster gas). At pH values greater than 7.5 the solution loses killing power and could be hazardous. For this reason **NEVER** mix chlorine and ammonia.

Attempting to add more chlorine to increase the solution microbial killing power is not effective unless the solution pH is maintained between 6 to 7.5

Although warmer solution temperatures can increase the microbial killing power, chlorine solutions work well at cool temperatures and tolerate hard water. Treatments on shrimp farms are usually applied as chilled dips. Careful preparation of the solution concentrations must account for the amount of ice in the solution.

What chlorine concentrations should be used in shrimp farming?

Based on recommendations in the United States, the concentration of chlorine residual that can be applied to foods, including shrimp, is 10 ppm. This recommendation is often confused by interpretation for the residual concentration before food application vs. as the solution is applied to the food. Likewise, there are conflicting recommendations from various countries.

	Recommended Chlorine Concentrations in Solution		
	Contacting Food	Food Contact Surfaces	Non-food Contact Surfaces
Codex	10	100-200	
USA	10	100-200	400
Thailand	2-10		
Canada	7		
Japan	1		
China	0.3		
Finland	0.1		

Source: ASEAN-Canada Fisheries Post-Harvest Technology Project, 1977.

In contrast, the recommended chlorine concentrations for cleaning food contact surfaces (tables, totes, bins, utensils) and non-food contact surfaces (floors, drains) are higher than for direct food contact.

How can the chlorine solution concentration be measured?

Chlorine concentrations are unstable in solution and will decrease when exposed to organic material like shrimp. The amount of decreased or absorbed chlorine is known as the ‘chlorine demand’. The amount of free or remaining chlorine is known as the ‘free chlorine’, which provides the microbial killing power. This free residual can be simply measured with chlorine test strips. Smell is <u>not</u> a reliable indication of chlorine concentration or killing power. At times, it may be necessary to add more chlorine to maintain the killing power as indicated by the residual measures with the strips.

MELANOSIS CONTROLS - SULFITES

Why it is necessary to use sulfiting agents in shrimp processing?

Sulfite agents, such as sodium bisulfite and sodium metabisulfite, are currently used to prevent melanosis or 'black spotting' on certain shrimp, lobsters and other crustaceans. These compounds prevent the chemical reactions caused by enzymes known as polyphenoloxidases (PPO), which are involved with the natural shellfish shedding process. After harvest and death, the PPO systems are still active and can promote the development of black pigments (melanin) about the shell and on the surface of the meat. Proper icing or freezing can reduce the PPO activity, but the enzyme activity slowly continues at refrigeration temperatures and can be accelerated in thawed product. The melanin or black discoloration is not a toxic or disease causing substance, but it is commonly interpreted as a sign for poor product quality and mishandling. Properly applied immediately after harvest, the sulfiting agents can reduce the PPO enzyme activity and provide some partial bleaching to help maintain the preferred shrimp and lobster appearance.

What concentration of sulfite agents should I use?

Previous experience dating back to the 1950's determined the recommended method for uniform and effective control of Penaeid shrimp melanosis was a 1 minute dip in a 1.25% sulfite solution, followed by rinsing, draining and storage in ice, refrigeration or as frozen. A higher concentration is no more effective in reducing melanosis, but it is more expensive and could cause quality problems such as pitted or sandpaper texture shells, and yellow discoloration.

What is the best application method for sulfites?

Sulfiting agents used to prevent shrimp melanosis are best applied immediately after harvest. The most effective treatment is to place the shrimp to be treated in a basket. Then immerse this basket in the 1.25% sulfite dip solution for 1 to 3 minutes. After treatment, shrimp are drained and then stored on ice for transport to processing plant. Unreliable and/or ineffective ways to use sulfites include sprinkling the power on the last top layer of ice or on each layer of shrimp. Also, it is not recommended to apply the sulfite treatments through applications in or on the ice used to cool the shrimp. These methods do not provide a uniform effective treatment, and possible overuse can result in a tougher meat texture and product weight loss.

In some situations, the farmer or processor may decide to keep the shrimp in a iced sulfite solution or slush for longer time or during transport to the processing plant. A 0.25% sulfites or less concentrated solution or should be used in this situation.

How do I prepare a sulfite solution?

Sulfite solutions are prepared by dissolving either sodium bisulfite or sodium metabisulfite in water. The following table shows quantities to use to prepare a 1.25% solution.

1.25% Sulfite Mixtures	
Clean Water	**Sulfiting Agent**
1 Liter	12.5 g
1 Gallon	47.3 g or 0.1 Lb
10 Gallons (85 lbs*)	1 Lb or 1.5 cups*
30 Gallons (250 Lbs)	3.1 Lbs or 4 1/2 cups*
60 Gallons (500 Lbs)	6.2 Lbs or 9 cups*

1 cup equals 8 fluid ounces, sulfiting agents come as powders

CAUTION !

Sulfite power can release toxic sulfur dioxide fumes when in contact with moisture or water. Store sulfite powers in sealed, water tight container placed in well-ventilated areas. Prepare sulfite solutions in well-ventilated or open areas. A 1.25% solution is not dangerous, but can irritate eyes and breathing if closely inhaled.

How many times can I use this solution?

Sulfite dips gradually lose their sulfite concentration or strength with use. It is recommended that dips be checked at regular intervals with test paper. These will change color according to the concentration of sulfites in the dip. Weak solutions should be discarded. Experience with a particular shrimp, shrimp sizes, and different farm conditions will indicate the best use rates. A general rule is treat 50 pounds of shrimp per 10 gallons of fresh solution

Does ice storage, thawing and cooking affect the sulfite residual on shrimp?

Prolonged icing, washes and thawing can partially reduce the residual amount of sulfite on treated shrimp. If prolonged storage of shrimp in ice or ice slush is necessary, an additional mild treatment may be applied at the processing plant. Experience will indicate the need for additional treatments. Thawing, peeling and washing can reduce residual levels on adulterated shrimp, but percent reductions are limited. Most typical cooking methods offer little advantage in reducing sulfite levels on shrimp.

How are sulfite agents regulated in shrimp?

There is no regulatory limit specified in the United States for the amount of sulfite residual that can be on shrimp, but it is implied that residuals less than 100 ppm are adequate to achieve the intended effect to prevent melanosis. Other countries have specified limits ranging from 60 to 100 ppm for raw shrimp, and as low as 30 ppm for cooked shrimp. These limits are not based on measures for product safety. The hazardous level for sulfite residuals is unknown and varies for different consumer sensitivities.

Why it is important to label sulfites in the product ingredient list?

Regulations have specified sulfite residual limits for many foods and prohibited use on fresh fruits and vegetables as sold or served raw. These controls are necessary to prevent adverse health effects for certain consumers, particularly hypersensitive asthmatic persons which could have severe respiratory and allergic type reactions that could be life threatening. Adverse health reactions are rare for sulfite treated shrimp, lobster and other crustaceans, yet continuing United States regulatory and consumer concerns advocate controls for sulfite use. Improper labeling is subject to regulatory seizure and penalties. Labeling declarations indicating products previously treated are required if the sulfite residual level on the raw or cooked shrimp is above 10 ppm.

It is necessary to monitor for sulfite residuals?

Usually, the processor or retail firm does not directly control sulfite applications. To assure product safety and regulatory compliance, these buyers need useful monitoring procedures. In most instances, monitoring of sulfite residuals should be an integral part of a firm's HACCP (Hazard Analysis Critical Control) program. HACCP monitoring procedures need to be rapid and convenient to suit daily on-site use, but the analytical procedures are complicated because of the sulfite residuals can be tightly bound to the edible muscle tissue.

How do I monitor for sulfite residuals in the edible portion of the shrimp?

Analytical procedures must measure the sulfite residual as it exits in the edible muscle. Simple test paper and test drops are recommended for routine screening during processing and buying. More accurate methods require a proper laboratory setting and trained personnel. The involved lab methods are not recommended for routine commercial settings, yet it offers a final contractual or third party option for analytical verification.

What screening procedures are available to monitor for sulfites?

Test Drops

Procedure - Direct application of one drop of an activator solution and one drop of test reagent to the product surface ('Alert' method available from Neogen Corp.).

Interpretation - Blue to violet color reactions indicate the presence of sulfites. A light violet hue or complete disappearance of color within one minute suggests excessive sulfite use. WARNING: There may be slight color variations observed for various shrimp species and other crustaceans. The utility of the test kit should be evaluated with the particular products in question. In other words, a firm should confirm possible color reactions with product that has no prior handling with any sulfite agents.

Limitations – This test is used to indicate presences or prior use of sulfating agents to treat shrimp. The test cannot be accurately used to measure ppm sulfite residual levels on the shrimp.

Test Papers

Procedure-Shrimp shell surface or between the shell and meat is touched for 30 seconds with a strip of sulfite paper. The sulfite present in the shrimp will produce a color change in the test paper.

Interpretation- The paper turns to a specific color depending on the concentration of sulfite present. Quantification of the strip color change is determined by comparison with a color chart provided on the container label.

Limitations- The test was developed for liquids, and so test results in many false positives that are very misleading (suggesting sulfites present with they are not present). The test cannot be accurately used to measure ppm sulfite residual levels on the shrimp.

Malachite Green Test

Procedure – This method is less accurate than the test drops. A certain amount of formulated green dye is applied to a certain amount of fine chopped or blended sample of edible shrimp or lobster meat.

Interpretation - Excessive sulfite residuals will bleach out the green color depending on the amount of dye and shrimp sample pre-measured to correspond to a certain sulfite level (i.e., 100 ppm or less). This method is useful to indicate presence of sulfites if the

dye is measured to bleach at approximately 50 ppm. Most effective sulfite treatments for shrimp leave a residual near or above 50 ppm.

Limitations - Interpretation requires experience with known standards and use of pictures for reference. Results only indicate compliance or excessive residuals about one set sulfite concentration.

What methods are available for verification of sulfite residuals?

Monier-Williams Test (Official Method)

Procedure - Prolonged acid and heat extraction utilizing special glassware and toxic chemicals, followed by tedious titration.

Interpretation - Represents the current official procedure recognized by regulatory authorities for determination of the actual sulfite residual concentration (i.e., ppm's).

Limitations - The results are subject to variation due to differences in product types and technical experience. The analytical detection limited for sulfite residuals is approximately 10 ppm. Which serves as the legal limit for required labeling for treated shrimp products.

Rapid Distillation and Redox Titration

Procedure - Acid distillation using specialized equipment followed by an iodine titration for an end-point color change.

Interpretation - Samples are steam distilled while the condensate is titrated with iodine. It is necessary to compare the color of the solution at the end-point to that of standards prepared at the beginning of the titration.

Limitation - Slight variations may occur due to subjective end-point determinations.

Volumetric Iodine Titration

Procedure: Alkali extraction followed by an iodine titration for an end-point color change Two shrimp samples are exposed to alkali solution. Then, they are neutralized, Hydrogen peroxide is added to one sample, and both are titrated with iodide solution.

Interpretation: Difference between samples is reported as concentration. The test is comparatively convenient, but it requires experience to judge the end point for titrations.

Limitation: Slight variations may occur due to subjective end-point determinations.

MELANOSIS CONTROL - EVERFRESH

What is EverFresh?

Everfresh is a common name for a special chemical (4-hexylresorcinol) that binds the enzyme that causes melanosis. After dipping in an Everfresh solution, melanosis will not occur after rinsing, refrigerating, freezing or thawing. It works best if applied when the shrimp are alive.

How can I use Everfresh at the farm?

EverFresh is used in dips just like sulfites. One pouch of EverFresh treats 250 kilograms (550 Lbs). Each pouch is dissolved in 25 gallons (95 liters) of available clean fresh water, brackish water or seawater. The only requirement is that it is non-chlorinated.

How long does it take to treat with EverFresh?

Shrimp are placed in a basket for a 2-minute dip with agitating up and down to make sure all surfaces come into contact with the EverFresh solution.

How do I prepare an Everfresh Solution?

Water	Pouches of Everfresh (200 g)	Recommend Amount of Shrimp (lbs) that can be treated before change solution
25 gallons (210 lbs)	1	500 to 600
50 gallons (420 lbs)	2	1000 to 1200
75 gallons (625 lbs)	3	1500 to 1800

What other things must be considered when using EverFresh?

- Treat shrimp before exposing the shrimp to chlorine solutions or concentrated brines.
- Avoid use of high concentrated chlorinated water.
- Water temperature should be between 2oC ands 27C. Everfresh works better at ambient temperature.
- Never sprinkle Everfresh directly onto seafood.
- Using more Everfresh or extending the time shrimp is submerged will not increase the effectiveness of EverFresh.

FARM-RAISED SHRIMP BUYER SPECIFICATION SHEET

Product Forms:	Whole, shell-on, peeled, cooked, or value added.
Origin:	Country of Origin (Nicaragua, Honduras, etc)
Color/species:	Each lot should be composed of a single species labeled on the box (Whites, Pinks, Tigers, Browns, etc)
Net Weight:	Net weight should be at least the declared weight on the box.
Count:	Lots should have the count declared on the box (For example, 26-30, this pack should have between 26 and 30 shrimp per pound)
Uniformity:	Uniformity ratio (UR) should be 1.5 or lower UR=Weight of 10% largest/weight of 10% of the smallest per pack.
Veins	Veins should not exceed more than 5% by count in peeled product.
Blackspots:	Shell-on or whole shrimp with noticeable blackspots should not exceed 5% by count .
Throat Meats:	Shell-on product should have no more than 5% by count. Peeled shrimp should be free of throat meat.
Extraneous Materials: (Antennas, legs, shells etc)	Product should be free of extraneous materials.
Pieces/Damaged:	Damaged shrimp should not be higher than 5% by count. Pieces should not be higher than 5% by count
Dehydration:	Frozen shrimp should be free of dehydration.
Odor/Flavor:	Odor and flavor should be fresh and typical of that shrimp species. (unacceptable odors include choclo, decomposition, petro-chemical, etc)
Shrink:	Shrinkage after cooking should be characteristic of the species.

Chemical Specs

Additives: Product should not be adulterated with chemicals.
Sulfites- follow buyers specs. Need to be reported on the ingredients list.
Everfresh- does not need to be reported on the ingredients list.
Phosphates- follow buyers specs i.e. 2% phosphate solution for 30 minutes. Should be reported on the ingredients list.

Microbiological Specs (Example only)

Salmonella	negative
Listeria monocytogenes	negative (for cooked product)
E. coli	Less than 500 per gram
Total coliforms	Less than 1,100 per gram
Total Aerobic Plate Counts	Less than 1×10^6 per gram

Evaluating Shrimp Quality

Raw Whole, Shell-on or Peeled Shrimp Quality Scale

Score	Quality Rating	Description
1	A	**Best shrimp** - No odor to fresh shrimp odor (Class I Decomposition) Firm texture. No melanosis
2	A	**Excellent shrimp** - very slight noticeable changes in odor, appearance, or texture
3	A	**Very good shrimp** - some noticeable but not objectionable changes
4	B	**Good shrimp** - noticeable changes in odor, appearance, and texture, but not objectionable
5	B	**Good to fair shrimp** - more noticeable changes, with some slightly objectionable, slightly stale or fishy odor, moderate melanosis, or slight soft texture (Class I Low Quality Decomposition)
6	B	**Fair shrimp** - similar to score 5 yet more pronounced
7	C	**Rather poor shrimp** - objectionable changes in odor (Class II Decomposition), appearance and texture. Musty, fishy, "old socks" or ammoniacal odor, heavy melanosis, "red legs" or heat abused appearance, soft texture
8	C	**Poor shrimp** - most quality attributes objectionable (Class III Decomposition) Putrid, ammoniacal or fecal odor, cooked appearance and/or heavy melanosis, and soft-mushy texture
9	C	**Very poor shrimp** - very objectionable

US REGULATORY TOLERANCES, METHODS AND AUTHORITES

PESTICIDES

Deleterious Substance	Level	Food Commodity
Aldrin/Dieldrin[a]	0.3 ppm	All fish
Benzene hexachloride	0.3 ppm	Frog legs
Chlordane	0.3 ppm	All fish
Chlordecone[b]	0.3 ppm	All fish
	0.4 ppm	Crabmeat
DDT, TDE, DDE[c]	5.0 ppm	All fish
Diquat[d]	0.1 ppm	All fish
Fluridone[d]	0.5 ppm	Fin fish and crayfish
Glyphosate[d]	0.25ppm	Fin fish
	3.0 ppm	Shellfish
Heptachlor / Heptachlor Epoxide[e]	0.3 ppm	All fish
Mirex	0.1 ppm	All fish
Polychlorinated Biphenyls (PCB's)[d]	2.0 ppm	All fish
Simazine[d]	12.0 ppm	Finfish
2,4-D[d]	1.0 ppm	All fish

Source: WWW.FDA.GOV , FDA's Fish & Fisheries Products Hazards & Control Guide: Second Edition 1998

TOXIC ELEMENTS

Toxic elements	Level	Food Commodity
Arsenic (total)	76 ppm	Crustacea
	86 ppm	Molluscan bivalves
Cadmium	3 ppm	Crustacea
	4 ppm	Molluscan bivalves
Chromium	12 ppm	Crustacea
	13 ppm	Molluscan bivalves
Lead	1.5 ppm	Crustacea
	1.7 ppm	Molluscan bivalves
Nickel	70 ppm	Crustacea
	80 ppm	Molluscan bivalves
Methyl Mercury[f]	1 ppm	All fish[b]

Source: WWW.FDA.GOV , FDA's Fish & Fisheries Products Hazards & Control Guide: Second Edition 1998

[a] The action level for aldrin and dieldrin are for residues of the pesticides individually or in combination. However, in adding amounts of aldrin and dieldrin, do not count aldrin or dieldrin found at below 0.1 ppm.
[b] Previously listed as Kepone, the trade name of chlordecone.
[c] The action level for DDT, TDE, and DDE are for residues of the pesticides individually or in combination. However, in adding amounts of DDT, TDE, and DDE, do not count any of the three found below 0.2 ppm.
[d] The levels published in 21 CFR & 40 CFR represent tolerances, rather than guidance levels or action levels.
[e] The action level for heptachlor and heptachlor epoxide is for the pesticides individually or in combination. However, in adding amounts of heptachlor and heptachlor epoxide, do not count heptachlor or heptachlor epoxide found below 0.1 ppm.
[f] See Chapter 25 for additional information. Note: the term "fish" refers to fresh or saltwater finfish, crustaceans, other forms of aquatic animal life other than birds or mammals, and all mollusks, as defined in 21 CFR 123.3(d).

Analytical Methodology for Chemical Contaminants and Therapeutic Agents

Lead

Lead in fish: Atomic absorption spectrophotometric method (AOAC, 1995d).
Lead in fish: Polarographic method (AOAC, 1995e).

Mercury

Mercury (methyl) in fish and shellfish: Gas chromatographic method (AOAC, 1995f)
Mercury (Methyl) in fish and shellfish: Rapid gas chromatographic method (AOAC, 1995g)
Mercury (methyl) in seafood: Liquid chromatographic - atomic absorption spectrophotometric method (AOAC, 1995h)

Pesticides

Organochlorine and organophosphorous pesticide residues: General multiresidue method (AOAC, 1995a).
Organochlorine and organophosphorous pesticide residues: Gas chromatographic method (AOAC, 1995b).
Organochlorine pesticide and polychlorinated biphenyl residues in fish - Gas chromatographic method (AOAC, 1995c).

Therapeutic agents

Oxitetracyclin in Feeds: (AOAC, 1995 Chapter 5, p.47)
Oxitetracyclin in Animal Tissue: (AOAC, 1995 Chapter 23, p.19)
Furanzolidone in Feed and Premixes: (AOAC, 1995 Chapter 5, p.11-13)
Chloramphenicol in milk: (AOAC, 1995 Chapter 33, p. 42-43)
Formaldehyde in Food: AOAC, 1995 Chapter 47, p. 16)

Food and Environmental Regulatory Agencies in the United States of America

(Source: publication B-5085 – Guide to Drug, Vaccine, and pesticide Use in Aquaculture)

a. **United States Food and Drug Administration (FDA)** – www.fda.gov : responsible for the safety, wholesomeness, and proper labeling of food products; responsible for assuring compliance with current seafood regulations, including HACCP.

b. **Center for Veterinary Medicine (CVM)** – www.usda.gov : responsible for the regulation of the manufacturing, distribution and proper use of animal drugs.

c. **Center for Food Science and Applied Nutrition (CFSAN)** – www.cfsan.fda.gov : responsible for conducting research and develop standards for the composition, quality, nutrition, labeling and safety of foods, food additives and color additives.

d. **U.S. Environmental Protection Agency (EPA)** – www.epa.gov: responsible for registering and licensing all pesticides used in the United States. Also, sets tolerances and maximum limits for pesticide residues in foods and animal feed.

e. **Animal and Plant Health Inspection Services (APHIS-USDA) –** www.usda.gov: regulates veterinary biologics produced in, shipped into, or exported from the US, including vaccines, therapeutants and diagnosis test kits.

State Regulatory Agencies – regulate all food processed or marketed for human consumption in each individual State.

CURRENT GOOD MANUFACTURING PRACTICE (21 CFR PART 110)

[Code of Federal Regulations]
[Title 21, Volume 2, Parts 100 to 169]
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[Page 206-207]

TITLE 21--FOOD AND DRUGS

CHAPTER I--FOOD AND DRUG ADMINISTRATION, DEPARTMENT OF HEALTH AND HUMAN
SERVICES--CONTINUED

PART 110--CURRENT GOOD MANUFACTURING PRACTICE IN MANUFACTURING, PACKING, OR HOLDING HUMAN FOOD—

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Subpart A--General Provisions

The definitions and interpretations of terms in section 201 of the Federal Food, Drug, and Cosmetic Act (the act) are applicable to such terms when used in this part. The following definitions shall also apply:

(a) Acid foods or acidified foods means foods that have an equilibrium pH of 4.6 or below.

(b) Adequate means that which is needed to accomplish the intended purpose in keeping with good public health practice.

(c) Batter means a semi fluid substance, usually composed of flour and other ingredients, into which principal components of food are dipped or with which they are coated, or which may be used directly to form bakery foods.

(d) Blanching, except for tree nuts and peanuts, means a prepackaging heat treatment of foodstuffs for a sufficient time and at a sufficient temperature to partially or completely inactivate the naturally occurring enzymes and to effect other physical or biochemical changes in the food.

(e) Critical control point means a point in a food process where there is a high probability that improper control may cause, allow, or contribute to a hazard or to filth in the final food or decomposition of the final food.

(f) Food means food as defined in section 201(f) of the act and includes raw materials and ingredients.

(g) Food-contact surfaces are those surfaces that contact human food and those surfaces from which drainage onto the food or onto surfaces that contact the food ordinarily occurs during the normal course of operations. "Food-contact surfaces" includes utensils and food-contact surfaces of equipment.

(h) Lot means the food produced during a period of time indicated by a specific code.

(i) Microorganisms means yeasts, molds, bacteria, and viruses and include, but is not limited to, species having public health significance. The term "undesirable microorganisms" includes those microorganisms that are of public health significance, that subject food to decomposition, that indicate that food is contaminated with filth, or that otherwise may cause food to be adulterated within the meaning of the act. Occasionally in these regulations, FDA used the adjective "microbial" instead of using an adjectival phrase containing the word microorganism.

(j) Pest refers to any objectionable animals or insects including, but not limited to, birds, rodents, flies, and larvae.

(k) Plant means the building or facility or parts thereof, used for or in connection with the manufacturing, packaging, labeling, or holding of human food.

(l) Quality control operation means a planned and systematic procedure for taking all actions necessary to prevent food from being adulterated within the meaning of the act.

(m) Rework means clean, unadulterated food that has been removed from processing for reasons other than unsanitary conditions or that has been successfully reconditioned by reprocessing and that is suitable for use as food.

(n) Safe-moisture level is a level of moisture low enough to prevent the growth of undesirable microorganisms in the finished product under the intended conditions of manufacturing, storage, and distribution. The maximum safe moisture level for a food is based on its water activity (aw). An aw will be considered safe for a food if adequate data are available that demonstrate that the food at or below the given aw will not support the growth of undesirable microorganisms.

(o) Sanitize means to adequately treat food-contact surfaces by a process that is effective in destroying vegetative cells of microorganisms of public health significance, and in substantially reducing numbers of other undesirable microorganisms, but without adversely affecting the product or its safety for the consumer.

(p) Shall is used to state mandatory requirements.

(q) Should is used to state recommended or advisory procedures or identify recommended equipment.

(r) Water activity (aw) is a measure of the free moisture in a food and is the quotient of the water vapor pressure of the substance divided by the vapor pressure of pure water at the same temperature.

Sec. 110.5 Current good manufacturing practice.

(a) The criteria and definitions in this part shall apply in determining whether a food is adulterated (1) within the meaning of section 402(a)(3) of the act in that the food has been manufactured under such conditions that it is unfit for food; or (2) within the meaning of section 402(a)(4) of the act in that the food has been prepared, packed, or held under unsanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health. The criteria and definitions in this part also apply in determining whether a food is in violation of section 361 of the Public Health Service Act (42 U.S.C. 264).

(b) Food covered by specific current good manufacturing practice regulations also is subject to the requirements of those regulations.

Sec. 110.10 Personnel.

The plant management shall take all reasonable measures and precautions to ensure the following:

(a) Disease control. Any person who, by medical examination or supervisory observation, is shown to have, or appears to have, an illness, open lesion, including boils, sores, or infected wounds, or any other abnormal source of microbial contamination by which there is a reasonable possibility of food, food-contact surfaces, or food-packaging materials becoming contaminated, shall be excluded from any operations which may be expected to result in such contamination until the condition is corrected. Personnel shall be instructed to report such health conditions to their supervisors.

(b) Cleanliness. All persons working in direct contact with food, food-contact surfaces, and food-packaging materials shall conform to hygienic practices while on duty to the extent necessary to protect against contamination of food. The methods for maintaining cleanliness include, but are not limited to:

(1) Wearing outer garments suitable to the operation in a manner that protects against the contamination of food, food-contact surfaces, or food-packaging materials.

(2) Maintaining adequate personal cleanliness.

(3) Washing hands thoroughly (and sanitizing if necessary to protect against contamination with undesirable microorganisms) in an adequate hand-washing facility before starting work, after each absence from the work station, and at any other time when the hands may have become soiled or contaminated.

(4) Removing all unsecured jewelry and other objects that might fall into food, equipment, or containers, and removing hand jewelry that cannot be adequately sanitized during periods in which food is manipulated by hand. If such hand jewelry cannot be removed, it may be covered by material which can be maintained in an intact, clean, and sanitary condition and which effectively protects against the contamination by these objects of the food, food-contact surfaces, or food-packaging materials.

(5) Maintaining gloves, if they are used in food handling, in an intact, clean, and sanitary condition. The gloves should be of an impermeable material.

.(6) Wearing, where appropriate, in an effective manner, hairnets, headbands, caps, beard covers, or other effective hair restraints.

(7) Storing clothing or other personal belongings in areas other than where food is exposed or where equipment or utensils are washed.

(8) Confining the following to areas other than where food may be exposed or where equipment or utensils are washed: eating food, chewing gum, drinking beverages, or using tobacco.

(9) Taking any other necessary precautions to protect against contamination of food, food-contact surfaces, or food-packaging materials with microorganisms or foreign substances including, but not limited to, perspiration, hair, cosmetics, tobacco, chemicals, and medicines applied to the skin.

. (c) Education and training. Personnel responsible for identifying sanitation failures or food contamination should have a background of education or experience, or a combination thereof, to provide a level of competency necessary for production of clean and safe food. Food handlers and supervisors should receive appropriate training in proper food handling techniques and food-protection principles and should be informed of the danger of poor personal hygiene and unsanitary practices.

(d) Supervision. Responsibility for assuring compliance by all personnel with all requirements of this part shall be clearly assigned to competent supervisory personnel.

[.51 FR 24475, June 19, 1986, as amended at 54 FR 24892, June 12, 1989]

Sec. 110.19 Exclusions.

(a) The following operations are not subject to this part:
Establishments engaged solely in the harvesting, storage, or distribution of one or more "raw agricultural commodities," as defined in section 201(r) of the act, which are ordinarily cleaned, prepared, treated, or otherwise processed before being marketed to the consuming public.

(b) FDA, however, will issue special regulations if it is necessary to cover these excluded operations.

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Subpart B--Buildings and Facilities

Sec. 110.20 Plant and grounds.

(a) Grounds. The grounds about a food plant under the control of the operator shall be kept in a condition that will protect against the contamination of food. The methods for adequate maintenance of grounds include, but are not limited to:

(1) Properly storing equipment, removing litter and waste, and cutting. weeds or grass within the immediate vicinity of the plant buildings or structures that may constitute an attractant, breeding place, or harborage for pests.

(2) Maintaining roads, yards, and parking lots so that they do not constitute a source of contamination in areas where food is exposed.

(3) Adequately draining areas that may contribute contamination to food by seepage, foot-borne filth, or providing a breeding place for pests.

(4) Operating systems for waste treatment and disposal in an adequate manner so that they do not constitute a source of contamination in areas where food is exposed. If the plant grounds are bordered by grounds not under the operator's control and not maintained in the manner described in paragraph (a) (1) through (3) of this section, care shall be exercised in the plant by inspection, extermination, or other means to exclude pests, dirt, and filth that may be a source of food contamination.

(b) Plant construction and design. Plant buildings and structures shall be suitable in size, construction, and design to facilitate maintenance and sanitary operations for food-manufacturing purposes. The plant and facilities shall:

(1) Provide sufficient space for such placement of equipment and storage of materials as is necessary for the maintenance of sanitary operations and the production of safe food.

(2) Permit the taking of proper precautions to reduce the potential for contamination of food, food-contact surfaces, or food-packaging materials with microorganisms, chemicals, filth, or other extraneous material. The potential for contamination may be reduced by adequate food safety controls and operating practices or effective design, including the separation of operations in which contamination is likely to occur, by one or more of the following means: location, time, partition, air flow, enclosed systems, or other effective means.

(3) Permit the taking of proper precautions to protect food in outdoor bulk fermentation vessels by any effective means, including:

(i) Using protective coverings.

(ii) Controlling areas over and around the vessels to eliminate harborages for pests.

(iii) Checking on a regular basis for pests and pest infestation.

(iv) Skimming the fermentation vessels, as necessary.

(4) Be constructed in such a manner that floors, walls, and ceilings may be adequately cleaned and kept clean and kept in good repair; that drip or condensate from fixtures, ducts and pipes does not contaminate food, food-contact surfaces, or food-packaging materials; and that aisles or working spaces are provided between equipment and walls and are adequately unobstructed and of adequate width to permit employees to perform their duties and to protect against contaminating food or food-contact surfaces with clothing or personal contact.

(5) Provide adequate lighting in hand-washing areas, dressing and locker rooms, and toilet rooms and in all areas where food is examined, processed, or stored and where equipment or utensils are cleaned; and provide safety-type light bulbs, fixtures, skylights, or other glass suspended over exposed food in any step of preparation or otherwise protect against food contamination in case of glass breakage.

(6) Provide adequate ventilation or control equipment to minimize odors and vapors (including steam and noxious fumes) in areas where they may contaminate food; and locate and operate fans and other air-blowing equipment in a manner that minimizes the potential for contaminating food, food-packaging materials, and food-contact surfaces.

(7) Provide, where necessary, adequate screening or other protection against pests.

Sec. 110.35 Sanitary operations.

(a) General maintenance. Buildings, fixtures, and other physical facilities of the plant shall be maintained in a sanitary condition and shall be kept in repair sufficient to prevent food from becoming adulterated within the meaning of the act. Cleaning and sanitizing of utensils and equipment shall be conducted in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials.

(b) Substances used in cleaning and sanitizing; storage of toxic materials.

(1) Cleaning compounds and sanitizing agents used in cleaning and sanitizing procedures shall be free from undesirable microorganisms and shall be safe and adequate under the conditions of use. Compliance with this requirement may be verified by any effective means including purchase of these substances under a supplier's guarantee or certification, or examination of these substances for contamination. Only the following toxic materials may be used or stored in a plant where food is processed or exposed:

(i) Those required to maintain clean and sanitary conditions;

(ii) Those necessary for use in laboratory testing procedures;

(iii) Those necessary for plant and equipment maintenance and operation; and

(iv) Those necessary for use in the plant's operations.

(2) Toxic cleaning compounds, sanitizing agents, and pesticide chemicals shall be identified, held, and stored in a manner that protects against contamination of food, food-contact surfaces, or food-packaging materials. All relevant regulations promulgated by other Federal, State, and local government agencies for the application, use, or holding of these products should be followed.

(c) Pest control. No pests shall be allowed in any area of a food plant. Guard or guide dogs may be allowed in some areas of a plant if the presence of the dogs is unlikely to result in contamination of food, food-contact surfaces, or food-packaging materials. Effective measures shall be taken to exclude pests from the processing areas and to protect against the contamination of food on the premises by pests. The use of insecticides or rodenticides is permitted only under precautions and restrictions that will protect against the contamination of food, food-contact surfaces, and food-packaging materials.

(d) Sanitation of food-contact surfaces. All food-contact surfaces, including utensils and food-contact surfaces of equipment, shall be cleaned as frequently as necessary to protect against contamination of food.

(1) Food-contact surfaces used for manufacturing or holding low-moisture food shall be in a dry, sanitary condition at the time of use.
When the surfaces are wet-cleaned, they shall, when necessary, be sanitized and thoroughly dried before subsequent use.

(2) In wet processing, when cleaning is necessary to protect against the introduction of microorganisms into food, all food-contact surfaces shall be cleaned and sanitized before use and after any interruption during which the food-contact surfaces may have become contaminated. Where equipment and utensils are used in a continuous production operation, the utensils and food-contact surfaces of the equipment shall be cleaned and sanitized as necessary.

(3) Non-food-contact surfaces of equipment used in the operation of food plants should be cleaned as frequently as necessary to protect against contamination of food.

(4) Single-service articles (such as utensils intended for one-time use, paper cups, and paper towels) should be stored in appropriate containers and shall be handled, dispensed, used, and disposed of in a manner that protects against contamination of food or food-contact surfaces.

(5) Sanitizing agents shall be adequate and safe under conditions of use. Any facility, procedure, or machine is acceptable for cleaning and sanitizing equipment and utensils if it is established that the facility, procedure, or machine will routinely render equipment and utensils clean and provide adequate cleaning and sanitizing treatment.

(e) Storage and handling of cleaned portable equipment and utensils. Cleaned and sanitized portable equipment with food-contact surfaces and utensils should be stored in a location and manner that protects food-contact surfaces from contamination.

[51 FR 24475, June 19, 1986, as amended at 54 FR 24892, June 12, 1989]

Sec. 110.37 Sanitary facilities and controls.

Each plant shall be equipped with adequate sanitary facilities and Accommodations including, but not limited to:

(a) Water supply. The water supply shall be sufficient for the operations intended and shall be derived from an adequate source. Any water that contacts food or food-contact surfaces shall be safe and of adequate sanitary quality. Running water at a suitable temperature, and under pressure as needed, shall be provided in all areas where required for the processing of food, for the cleaning of equipment, utensils, and food-packaging materials, or for employee sanitary facilities.

(b) Plumbing. Plumbing shall be of adequate size and design and adequately installed and maintained to:

(1) Carry sufficient quantities of water to required locations throughout the plant.

(2) Properly convey sewage and liquid disposable waste from the plant.

(3) Avoid constituting a source of contamination to food, water supplies, equipment, or utensils or creating an unsanitary condition.

(4) Provide adequate floor drainage in all areas where floors are subject to flooding-type cleaning or where normal operations release or discharge water or other liquid waste on the floor.

(5) Provide that there is not backflow from, or cross-connection between, piping systems that discharge wastewater or sewage and piping systems that carry water for food or food manufacturing.

(c) Sewage disposal. Sewage disposal shall be made into an adequate sewerage system or disposed of through other adequate means.

(d) Toilet facilities. Each plant shall provide its employees with adequate, readily accessible toilet facilities. Compliance with this requirement may be accomplished by:

(1) Maintaining the facilities in a sanitary condition.

(2) Keeping the facilities in good repair at all times.

(3) Providing self-closing doors.

(4) Providing doors that do not open into areas where food is exposed to airborne contamination, except where alternate means have been taken to protect against such contamination (such as double doors or positive air-flow systems).

(e) Hand-washing facilities. Hand-washing facilities shall be adequate and convenient and be furnished with running water at a suitable temperature. Compliance with this requirement may be accomplished by providing:

(1) Hand-washing and, where appropriate, hand-sanitizing facilities at each location in the plant where good sanitary practices require employees to wash and/or sanitize their hands.

(2) Effective hand-cleaning and sanitizing preparations.

(3) Sanitary towel service or suitable drying devices.

(4) Devices or fixtures, such as water control valves, so designed and constructed to protect against recontamination of clean, sanitized hands.

(5) Readily understandable signs directing employees handling unprotected food, unprotected food-packaging materials, of food-contact surfaces to wash and, where appropriate, sanitize their hands before they start work, after each absence from post of duty, and when their hands may have become soiled or contaminated. These signs may be posted in the processing room(s) and in all other areas where employees may handle such food, materials, or surfaces.

(6) Refuse receptacles that are constructed and maintained in a manner that protects against contamination of food.

(f) Rubbish and offal disposal. Rubbish and any offal shall be so conveyed, stored, and disposed of as to minimize the development of odor, minimize the potential for the waste becoming an attractant and harborage or breeding place for pests, and protect against contamination of food, food-contact surfaces, water supplies, and ground surfaces.

Subpart C--Equipment

Sec. 110.40 Equipment and utensils.

(a) All plant equipment and utensils shall be so designed and of such material and workmanship as to be adequately cleanable, and shall be properly maintained. The design, construction, and use of equipment and utensils shall preclude the adulteration of food with lubricants, fuel, metal fragments, contaminated water, or any other contaminants. All equipment should be so installed and maintained as to facilitate the cleaning of the equipment and of all adjacent spaces. Food-contact surfaces shall be corrosion-resistant when in contact with food. They shall be made of nontoxic materials and designed to withstand the environment of their intended use and the action of food, and, if applicable, cleaning compounds and sanitizing agents. Food-contact surfaces shall be maintained to protect food from being contaminated by any source, including unlawful indirect food additives.

(b) Seams on food-contact surfaces shall be smoothly bonded or maintained so as to minimize accumulation of food particles, dirt, and organic matter and thus minimize the opportunity for growth of microorganisms.

(c) Equipment that is in the manufacturing or food-handling area and that does not come into contact with food shall be so constructed that it can be kept in a clean condition.

(d) Holding, conveying, and manufacturing systems, including gravimetric, pneumatic, closed, and automated systems, shall be of a design and construction that enables them to be maintained in an appropriate sanitary condition.

(e) Each freezer and cold storage compartment used to store and hold food capable of supporting growth of microorganisms shall be fitted with an indicating thermometer, temperature-measuring device, or temperature-recording device so installed as to show the temperature accurately within the compartment, and should be fitted with an automatic control for regulating temperature or with an automatic alarm system to indicate a significant temperature change in a manual operation.

(f) Instruments and controls used for measuring, regulating, or recording temperatures, pH, acidity, water activity, or other conditions that control or prevent the growth of undesirable microorganisms in food shall be accurate and adequately maintained, and adequate in number for their designated uses.

(g) Compressed air or other gases mechanically introduced into food or used to clean food-contact surfaces or equipment shall be treated in such a way that food is not contaminated with unlawful indirect food additives.

Subpart E--Production and Process Controls

Sec. 110.80 Processes and controls.

All operations in the receiving, inspecting, transporting, segregating, preparing, manufacturing, packaging, and storing of food shall be conducted in accordance with adequate sanitation principles. Appropriate quality control operations shall be employed to ensure that food is suitable for human consumption and that food-packaging materials are safe and suitable. Overall sanitation of the plant shall be under the supervision of one or more competent individuals assigned responsibility for this function. All reasonable precautions shall be taken to ensure that production procedures do not contribute contamination from any source. Chemical, microbial, or extraneous-material testing procedures shall be used where necessary to identify sanitation failures or possible food contamination. All food that has become contaminated to the extent that it is adulterated within the meaning of the act shall be rejected, or if permissible, treated or processed to eliminate the contamination.

(a) Raw materials and other ingredients. (1) Raw materials and other ingredients shall be inspected and segregated or otherwise handled as necessary to ascertain that they are clean and suitable for processing into food and shall be stored under conditions that will protect against contamination and minimize deterioration. Raw materials shall be washed or cleaned as necessary to remove soil or other contamination. Water used for washing, rinsing, or conveying food shall be safe and of adequate sanitary quality. Water may be reused for washing, rinsing, or conveying food if it does not increase the level of contamination of the food. Containers and carriers of raw materials should be inspected on receipt to ensure that their condition has not contributed to the contamination or deterioration of food.

(2) Raw materials and other ingredients shall either not contain levels of microorganisms that may produce food poisoning or other disease in humans, or they shall be pasteurized or otherwise treated during manufacturing operations so that they no longer contain levels that would cause the product to be adulterated within the meaning of the act. Compliance with this requirement may be verified by any effective means, including purchasing raw materials and other ingredients under a supplier's guarantee or certification.

(3) Raw materials and other ingredients susceptible to contamination with aflatoxin or other natural toxins shall comply with current Food and Drug Administration regulations, guidelines, and action levels for poisonous or deleterious substances before these materials or ingredients are incorporated into finished food. Compliance with this requirement may be accomplished by purchasing raw materials and other ingredients under a supplier's guarantee or certification, or may be verified by analyzing these materials and ingredients for aflatoxins and other natural toxins.

(4) Raw materials, other ingredients, and rework susceptible to contamination with pests, undesirable microorganisms, or extraneous material shall comply with applicable Food and Drug Administration regulations, guidelines, and defect action levels for natural or unavoidable defects if a manufacturer wishes to use the materials in manufacturing food. Compliance with this requirement may be verified by any effective means, including purchasing the materials under a supplier's guarantee or certification, or examination of these materials for contamination.

(5) Raw materials, other ingredients, and rework shall be held in bulk, or in containers designed and constructed so as to protect against contamination and shall be held at such temperature and relative humidity and in such a manner as to prevent the food from becoming adulterated within the meaning of the act. Material scheduled for rework shall be identified as such.

(6) Frozen raw materials and other ingredients shall be kept frozen. If thawing is required prior to use, it shall be done in a manner that prevents the raw materials and other ingredients from becoming adulterated within the meaning of the act.

(7) Liquid or dry raw materials and other ingredients received and stored in bulk form shall be held in a manner that protects against contamination.

(b) Manufacturing operations.

(1) Equipment and utensils and finished food containers shall be maintained in an acceptable condition through appropriate cleaning and sanitizing, as necessary. Insofar as necessary, equipment shall be taken apart for thorough cleaning.

(2) All food manufacturing, including packaging and storage, shall be conducted under such conditions and controls as are necessary to minimize the potential for the growth of microorganisms, or for the contamination of food. One way to comply with this requirement is careful monitoring of physical factors such as time, temperature, humidity, aw, pH, pressure, flow rate, and manufacturing operations such as freezing, dehydration, heat processing, acidification, and refrigeration to ensure that mechanical breakdowns, time delays, temperature fluctuations, and other factors do not contribute to the decomposition or contamination of food.

(3) Food that can support the rapid growth of undesirable microorganisms, particularly those of public health significance, shall be held in a manner that prevents the food from becoming adulterated within the meaning of the act. Compliance with this requirement may be accomplished by any effective means, including:

(i) Maintaining refrigerated foods at 45 °F (7.2 °C) or below as appropriate for the particular food involved.

(ii) Maintaining frozen foods in a frozen state.

(iii) Maintaining hot foods at 140 °F (60 °C) or above.

(iv) Heat treating acid or acidified foods to destroy mesophilic microorganisms when those foods are to be held in hermetically sealed containers at ambient temperatures.

(4) Measures such as sterilizing, irradiating, pasteurizing, freezing, refrigerating, controlling pH or controlling aw that are taken to destroy or prevent the growth of undesirable microorganisms, particularly those of public health significance, shall be adequate under the conditions of manufacture, handling, and distribution to prevent food from being adulterated within the meaning of the act.

(5) Work-in-process shall be handled in a manner that protects against contamination.

(6) Effective measures shall be taken to protect finished food from contamination by raw materials, other ingredients, or refuse. When raw materials, other ingredients, or refuse are unprotected, they shall not be handled simultaneously in a receiving, loading, or shipping area if that handling could result in contaminated food. Food transported by conveyor shall be protected against contamination as necessary.

(7) Equipment, containers, and utensils used to convey, hold, or store raw materials, work-in-process, rework, or food shall be constructed, handled, and maintained during manufacturing or storage in a manner that protects against contamination.

(8) Effective measures shall be taken to protect against the inclusion of metal or other extraneous material in food. Compliance with this requirement may be accomplished by using sieves, traps, magnets, electronic metal detectors, or other suitable effective means.

(9) Food, raw materials, and other ingredients that are adulterated within the meaning of the act shall be disposed of in a manner that protects against the contamination of other food. If the adulterated food is capable of being reconditioned, it shall be reconditioned using a method that has been proven to be effective or it shall be reexamined and found not to be adulterated within the meaning of the act before being incorporated into other food.

(10) Mechanical manufacturing steps such as washing, peeling, trimming, cutting, sorting and inspecting, mashing, dewatering, cooling, shredding, extruding, drying, whipping, defatting, and forming shall be performed so as to protect food against contamination. Compliance with this requirement may be accomplished by providing adequate physical protection of food from contaminants that may drip, drain, or be drawn into the food. Protection may be provided by adequate cleaning and sanitizing of all food-contact surfaces, and by using time and temperature controls at and between each manufacturing step.

(11) Heat blanching, when required in the preparation of food, should be effected by heating the food to the required temperature, holding it at this temperature for the required time, and then either rapidly cooling the food or passing it to subsequent manufacturing without delay. Thermophilic growth and contamination in blanchers should be minimized by the use of adequate operating temperatures and by periodic cleaning. Where the blanched food is washed prior to filling, water used shall be safe and of adequate sanitary quality.

(12) Batters, breading, sauces, gravies, dressings, and other similar preparations shall be treated or maintained in such a manner that they are protected against contamination. Compliance with this requirement may be accomplished by any effective means, including one or more of the following:

(i) Using ingredients free of contamination.

(ii) Employing adequate heat processes where applicable.

(iii) Using adequate time and temperature controls.

(iv) Providing adequate physical protection of components from contaminants that may drip, drain, or be drawn into them.

(v) Cooling to an adequate temperature during manufacturing.

(vi) Disposing of batters at appropriate intervals to protect against the growth of microorganisms.

(13) Filling, assembling, packaging, and other operations shall be performed in such a way that the food is protected against contamination. Compliance with this requirement may be accomplished by any effective means, including:

(i) Use of a quality control operation in which the critical control points are identified and controlled during manufacturing.

(ii) Adequate cleaning and sanitizing of all food-contact surfaces and food containers.

(iii) Using materials for food containers and food- packaging materials that are safe and suitable, as defined in Sec. 130.3(d) of this chapter.

(iv) Providing physical protection from contamination, particularly airborne contamination.

(v) Using sanitary handling procedures.

(14) Food such as, but not limited to, dry mixes, nuts, intermediate moisture food, and dehydrated food, that relies on the control of aw for preventing the growth of undesirable microorganisms shall be processed to and maintained at a safe moisture level. Compliance with this requirement may be accomplished by any effective means, including employment of one or more of the following practices:

(i) Monitoring the aw of food.

(ii) Controlling the soluble solids-water ratio in finished food.

(iii) Protecting finished food from moisture pickup, by use of a moisture barrier or by other means, so that the aw of the food does not increase to an unsafe level.

(15) Food such as, but not limited to, acid and acidified food, that relies principally on the control of pH for preventing the growth of undesirable microorganisms shall be monitored and maintained at a pH of 4.6 or below. Compliance with this requirement may be accomplished by any effective means, including employment of one or more of the following practices:

(i) Monitoring the pH of raw materials, food in process, and finished food.

(ii) Controlling the amount of acid or acidified food added to low-acid food.

(16) When ice is used in contact with food, it shall be made from water that is safe and of adequate sanitary quality, and shall be used only if it has been manufactured in accordance with current good manufacturing practice as outlined in this part.

(17) Food-manufacturing areas and equipment used for manufacturing human food should not be used to manufacture nonhuman food-grade animal feed or inedible products, unless there is no reasonable possibility for the contamination of the human food.

Subpart E--Production and Process Controls

Sec. 110.93 Warehousing and distribution.

Storage and transportation of finished food shall be under conditions that will protect food against physical, chemical, and microbial contamination as well as against deterioration of the food and the container.

Subpart G--Defect Action Levels

Sec. 110.110 Natural or unavoidable defects in food for human use that present no health hazard.

(a) Some foods, even when produced under current good manufacturing practice, contain natural or unavoidable defects that at low levels are not hazardous to health. The Food and Drug Administration establishes maximum levels for these defects in foods produced under current good manufacturing practice and uses these levels in deciding whether to recommend regulatory action.

(b) Defect action levels are established for foods whenever it is necessary and feasible to do so. These levels are subject to change upon the development of new technology or the availability of new information.

(c) Compliance with defect action levels does not excuse violation of the requirement in section 402(a)(4) of the act that food not be prepared, packed, or held under unsanitary conditions or the requirements in this part that food manufacturers, distributors, and holders shall observe current good manufacturing practice. Evidence indicating that such a violation exists causes the food to be adulterated within the meaning of the act, even though the amounts of natural or unavoidable defects are lower than the currently established defect action levels. The manufacturer, distributor, and holder of food shall at all times utilize quality control operations that reduce natural or unavoidable defects to the lowest level currently feasible.

(d) The mixing of a food containing defects above the current defect action level with another lot of food is not permitted and renders the final food adulterated within the meaning of the act, regardless of the defect level of the final food.

(e) A compilation of the current defect action levels for natural or unavoidable defects in food for human use that present no health hazard may be obtained upon request from the Center for Food Safety and Applied Nutrition (HFS-565), Food and Drug Administration, 200 C St. SW., Washington, DC 20204.

[51 FR 24475, June 19, 1986, as amended at 61 FR 14480, Apr. 2, 1996]

SOURCES FOR ADDITIONAL INFORMATION

Seafood HACCP, Safety, and Quality on the Internet: Selected Site List with Brief Descriptions

21 USC Chapter 9 – Federal Food, Drug and Cosmetic Act
http://www.law.cornell.edu/uscode/21/ch9.html
Access to the US Code Title 21 – Foods and Drugs, with a direct link to the Federal Food, Drug, and Cosmetic Act.

AFSIC Aquaculture Resources – NAL USDA
http://www.nal.usda.gov/afsic/afsaqua.htm
Includes a very large database of aquaculture-related web sites and links.

Aquaculture Network Information Center (AquaNIC) Home Page
http://ag.ansc.purdue.edu/aquanic/
Good source of aquaculture newsletters and more aquaculture-related links.

ASEAN Fisheries Post-Harvest Information Network
http://www.asean.fishnet.gov.sg/p19.html
A diverse site from Southeast Asia which includes online publications (i.e., Hazard Control for Aquacultured Shrimp) and the Marine Fisheries Research Department Online Library Search.

Codex Alimentarius Commission
http://www.fao.org/waicent/faoinfo/economic/esn/CODEX/Default.htm
General site covering Codex Alimentarius activities including committee reports and meetings.

Codex Alimentarius – Basic Texts on Food Hygiene
http://www.fao.org/waicent/faoinfo/economic/esn/CODEX/STANDARD/fh_basic.pdf
Downloadable Texts which include General Principles of Food Hygiene and HACCP.

CSIRO Australia
http://www.csiro.au/
General information site of the Commonwealth Scientific and Industrial Research Organization of Australia. Food Processing and Meat, Dairy, and Aquaculture Divisions are relevant.

CSIRO Aquaculture Introduction
http://www.marine.csiro.au/aquaculture/intro.html
Further information from CSIRO concerning aquaculture and marine research. This web site can be slow and difficult to connect to.

Europa – European Union Policy
http://europa.eu.int/
European Union Policy site addressing production and marketing of fish and fishery products, as well as meat, eggs, etc.

Food and Drug Administration Home Page
http://www.fda.gov/
Gateway into the FDA web site.

FDA - Center for Food Safety & Applied Nutrition - Seafood
http://vm.cfsan.fda.gov/seafood1.html
Excellent source of seafood HACCP and Safety information. Site includes the Seafood HACCP Final Rule, the Fish and Fishery Products Hazards and Controls Guide, Seafood HACCP Question and Answer, and great links to further sites.

FDA - Office of Regulatory Affairs
http://www.fda.gov/ora/ora_home_page.html
A direct link to FDA Compliance Policy Guides and Regulatory Procedures Manual, this site also includes Inspectional References, Science References, and the Import Program.

Harbor Branch Oceanographic Institution, Inc.
http://www.hboi.edu/
This site has sections directed toward teaching and research in the areas of aquaculture of fish, shellfish, and crustaceans. Culture methods and systems are emphasized.

InfoFish
http://www.jaring.my/infofish/
A good web site that is published by an intergovernmental organization that provides marketing and technical information to the Asian-Pacific seafood industry. The most useful links are The Fish Inspector and InfoFish International.

Infopesca - Spanish
http://tips.org.uy/infopesca/
Similar to InfoFish site but developed for the Latin American and Caribbean region.

National Food Safety Database USDA-FDA Foodborne…Database
http://www.foodsafety.org/dbseai.htm
Food safety information for a wide variety of food products, including seafood, in a searchable format.

NOAA Fisheries – National Marine Fisheries Service
http://www.nmfs.gov/
This web site has links to a wide variety of fisheries issues. The Seafood Inspection Division is of particular interest with sections related to HACCP and Sensory Training, Publications (HACCP and Sanitation), and International Activities. There is also a link to a very useful NMFS Fisheries Statistics Page.

SeafoodNIC Home Page
http://www-seafood.ucdavis.edu/
The Seafood Network Information Center web site in an excellent overall web site with very useful links to the Seafood HACCP Alliance, UC Davis Seafood Information, and the IFT Seafood Technology Division. The Seafood HACCP Alliance section has links to Guidelines and Regulations and the Compendium of Fish and Fishery Products Processes, Hazards and Controls. There are also good links to other information sources.

Seafood NIC Home Page – HACCP Plans
http://www-seafood.ucdavis.edu/haccp/Plans.htm
This site is a direct link to UC Davis Seafood Information Generic HACCP Plans.