



University of California
Cooperative Extension

Cottage Food Operator's Handbook

Food Safety

JULY 2014

UNIVERSITY OF CALIFORNIA

DAVIS, CA



UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

Acknowledgements

This handbook could not have been produced without the dedicated efforts of the following University of California Cooperative Extension educators who were members of Training Team for Cottage Food Operations:

- Project Director: Shermain Hardesty, Cooperative Extension Specialist-Agricultural and Resource Economics, UC Davis and Leader, UC Small Farm Program
- Deborah Giraud, Farm and Community / Economic Development Advisor, Humboldt County
- Concepcion Mendoza, Nutrition, Family and Consumer Sciences Advisor, Shasta and Trinity Counties
- Diane Metz, Emeritus Nutrition, Family and Consumer Science Advisor, Yolo and Solano Counties
- Susan Mosbacher, Program Representative for Master Gardener and Master Food Preserver programs, Central Sierra
- Scott Oneto, Farm Advisor/Region Director, Central Sierra
- Dorothy Smith, Nutrition Family and Consumer Science Advisor, Central Sierra
- Julia Van Soelen Kim, North Bay Food Systems Advisor, Marin, Sonoma and Mendocino Counties

Sincere appreciation is also extended for the technical support provided by Linda Harris, Food Safety and Applied Microbiology Specialist, Department of Food Science and Technology, UC Davis.

Administrative support was cheerfully provided by Vera Allen, UCCE Central Sierra.

This handbook was partially funded by a California Department of Food and Agriculture Specialty Crop Block Grant.

Brand names and company names are included for educational purposes. No endorsement is implied nor is discrimination intended against similar products or services.

Additional information regarding this project may be obtained by contacting Shermain Hardesty, shermain@primal.ucdavis.edu, or <http://ucanr.edu/cottagefoods>

FOOD SAFETY

TABLE OF CONTENTS

Introduction.....	1
Causes of Foodborne Illness	1
Sources of Foodborne Illness	2
Bacteria	2
Viruses	9
Parasites	9
Natural Toxins	10
Environmental Toxins	12
Prevention of Foodborne Illness	12
Practice Personal Hygiene and Effective Cleaning Techniques.....	12
Avoid Cross-Contamination.....	13
Cook Food Adequately	13
Keep Foods at Safe Temperatures	14
Avoid Risky Foods and Water	14
Basis of Spoilage and Preservation.....	14
Microbial Spoilage.....	15
Enzyme Action.....	15
Oxygen	16
Insect Infestation	16
Moisture Loss	16
Food Preservation on the Web	16
Q & A.....	18
Resources.....	20

FOOD SAFETY

Introduction

This section broadly addresses food safety and is adapted from material that provides a background for home cooks. Therefore, some products are mentioned that are not allowed in the cottage food law. Since Cottage Food Operators are preparing food in a home kitchen, information here can help with all food preparation and handling. The law states that home cooking and cottage food preparation cannot occur at the same time. Ingredients used must be from an approved source. Discuss “approved source” with the Environmental Health staff from who you receive your permit.

Causes of Foodborne Illness

The five main groups of pathologic agents responsible for foodborne illnesses are:

- Bacteria
- Viruses
- Parasites
- Natural Toxins
- Environmental Toxins

In 2011, it is estimated that there were 48 million cases of foodborne illness per year in the U.S. It is estimated that 128,000 of these cases are serious enough to require hospitalization and 3,000 cases resulted in death (Centers for Disease Control). Foodborne illness can result in long-term detrimental health effects such as arthritis. The most severe cases tend to occur in the very old, the very young, those who have an illness already that reduces their immune system function, and in healthy people exposed to a very high dose of a pathogen. Pathogens are disease-causing microorganisms, such as those responsible for foodborne illnesses.

Foodborne illness costs this country nearly \$7 billion per year in medical care and lost productivity. The most common symptoms of foodborne illness are diarrhea, abdominal cramps, vomiting, head or muscle aches, and fever. Symptoms usually appear 12 to 72 hours after eating contaminated food, but may occur between 30 minutes and 4 weeks later. Many people who think they have the “24-hour bug” actually are suffering from a mild case of foodborne illness.

Many foodborne pathogens, such as *Salmonella*, have been recognized for years. Cases of these traditional pathogens continue to cause significant illness. Over the past thirty years, additional pathogens, such as *Listeria monocytogenes* and *E. coli* O157:H7, have been recognized and also cause foodborne illness.

The increased number of cases of foodborne illness has several reasons:

- Increased awareness and surveillance—more of the individuals who become sick (cases) are reported.
- Increased percentage of food is raw or minimally processed—we cook food less than we used to. Cooking is a good way to reduce pathogens in foods.
- Increased percentage of susceptible individuals. The young, old and immune compromised (people who have some other illness) are more susceptible to getting foodborne illness and more likely to have a severe form.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

- Food preparation skills are decreasing and we eat out more.
- Poor personal hygiene and mishandling of food during home cooking or in food service establishments is thought to be a contributing factor in many foodborne illnesses.

High-risk Populations: People who have a weakened immune system, pregnant women, newborn children five years of age, older adults aged 50 and older, and people with chronic diseases, are particularly vulnerable to foodborne infections.

Sources of Foodborne Illness

Pathogens (microorganisms which cause illness) are widely distributed in the environment. The intestines of animals, including humans, contain bacteria, parasites and viruses, which can cause illness. Animal feces can contaminate soil, which in turn can contaminate plants. Most known foodborne pathogens are bacteria, but foodborne illness is also caused by viruses and animal feces which can contaminate:

- Meat and poultry
- Soil, which in turn can contaminate plants
- Water, which in turn can contaminate fish and shellfish

Foods that contain a foodborne pathogen may look, smell and taste normal; they do not produce identifiable color, odor or flavor changes in the foods in which they multiply.

1. Bacteria—General characteristics

Bacteria are rod-shaped, round, or spiral in form. They grow and increase in number by splitting in two. Bacteria that cause diseases are known as *pathogens*. Many non-pathogenic bacteria cause spoilage if allowed to grow on food. A number of bacteria are also “good guys” and desirable in food; for example the bacteria involved in fermentation processes to produce cheese, pickles, and sauerkraut.

Pathogens cannot be eliminated from the food supply. In order to prevent foodborne illness, food must be handled properly throughout the food chain including a home kitchen. Preventing the growth of microorganisms in food is an important tool in preventing foodborne illness. Knowing about how microorganisms grow, aids in understanding how to control their growth.

The eight factors that affect the growth of microorganisms are:

- Temperature
- Water
- Nutrients
- Oxygen
- Acidity (pH)
- Time
- Inhibitors
- Initial Concentration

These factors are also important in determining the type of bacteria that can grow in food and the rate at which they grow. Some of these factors can be controlled for the purpose of preserving foods.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

Temperature: Foodborne pathogens grow best under the same conditions that allow people to thrive. Most foodborne bacteria grow fastest at temperatures from 90 to 110°F. However, foodborne bacteria will grow in the temperature range known as the **Danger Zone, 41° F to 135 °F**; a few will even grow at temperatures below this range. When we use the term “growth”, we mean an increase in numbers of the population.

Bacteria can increase in number very quickly; a few can even double in number every 10 minutes. The following chart illustrates how quickly one bacterium can multiply to dangerous numbers, given ideal conditions and doubling every 15 minutes at 80°F.

Amount of Time	Number of bacteria
Start	1
30 minutes	4
1 hour	16
1-1/2 hours	64
2 hours	256
2-1/2 hours	1,024
3 hours	4,096
3-1/2 hours	16,384
4 hours	65,536

Spoilage is normally detected when populations reach from 1 to 10 million organisms per gram of food, at this point food develops a sour or putrid odor and/or a slimy texture (*1 ounce equals about 28 grams of food.*) If bacteria are given the right conditions which requires ideal conditions of warm temperatures, moisture and so forth, they can multiply very rapidly on food.

Food temperature is very important in controlling bacterial growth. Different types of bacteria require different temperatures for maximum growth. At temperatures above and below the optimum, bacteria multiply at a slower rate. Let's examine a food, which initially contained 10,000 bacterial cells per gram, after two days at different storage temperatures in Chart 1.

CHART 1

If the food storage temperature is:	Then the number of bacterial cells after two days could be:
33°F	30,000 cells per gram of food
40°F	160,000
50°F	692,000,000
60°F	21,400,000,000

Source: Washington State University: Master Food Preserver Manual

Temperatures below 41° F and above 135 °F prevent the growth of most foodborne pathogens. A few pathogens can grow at refrigerator temperatures (for example, *Listeria*, has been shown to grow at temperatures as low as 29°F). Food spoilage bacteria grow best at environmental temperatures of 70° to 100°F but many can multiply at refrigerator temperatures. While foodborne pathogens cease to grow at temperatures around and below freezing, freezing does not kill most of them. Once the food is thawed, the pathogens resume growth.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

Water: Microorganisms require moisture for growth, bacteria, for example, thrive on moist foods. Dehydration preserves foods by removing moisture. In foods, **water activity** is a term that describes the amount of water available to microorganisms. It differs somewhat from **water content**, because water in food can be tied up by food components, such as sugar or salt, and be unavailable to microorganisms.

Various bacteria, yeasts and molds have different water activity requirements. Chart 2 illustrates the types of microorganisms that will grow at various water activities:

CHART 2

Water Activity	Microorganism That Can Grow	Food with This Water Activity
0.91	Normal bacteria	Fresh meat, milk
0.88	Normal yeasts	Fruit juice concentrates
0.80	Normal molds	Jams, jellies
0.75	Salt tolerant bacteria	Honey
0.65	Molds tolerant of low water	Some dried fruits
0.60	High sugar-content tolerant yeast	Some dried fruits

Salt and sugar decrease the water activity in foods by causing free water to bind to the sugar or salt, thus becoming unavailable for microorganisms. The use of sugar in jams and jellies and of a concentrated salt solution in pickling and brining are effective methods of food preservation because they lower the activity of water enough (typically 0.65) so that it can no longer support growth of most of the microorganisms, which cause food spoilage. Salt lowers the activity of water more effectively than sugar.

Nutrients: Some microorganisms need only simple salts, sugars, water, and minerals for growth. Others have additional requirements, such as amino acids, vitamins, and more complex carbohydrates.

Oxygen: Many microorganisms *require* oxygen to grow, some find oxygen toxic and many others are fine with or without oxygen. Bacteria can be classified by their oxygen requirements. *Anaerobic* microorganisms find oxygen toxic. *Aerobic* organisms must have an oxygen content of 16 to 21 percent to grow (atmospheric oxygen is about 20%). Controlling oxygen content is not a good way for home food preservers to control bacterial growth; if you make the oxygen content unfavorable for one group of bacteria, you may be encouraging the growth of another group.

Acidity: Bacterial growth is also affected by the acidity or alkalinity in food. Most microorganisms grow best under neutral pH--meaning neither acid nor alkaline (very few foods are highly alkaline.) Pathogenic bacteria do not grow in high acid foods. Use of the term **pH** is preferred when talking about this effect, since it is an accurate measure of acidity or alkalinity. The pH scale ranges from 0 to 14. A pH value of 7 is neutral, neither acid nor alkaline. Below 7, as the numbers decrease, the scale becomes increasingly more acidic. Above 7, increasing values reflect increasing alkalinity.

CHART 3 -pH of Some Common Foods

	Average Values for Common Foods	pH	Average Values for Common Foods
2.0	Limes	5.0	Pumpkins, carrots
2.2	Lemons	5.1	Cucumbers, peppers, papaya
2.9	Vinegar, plums (2.8-4.6)	5.2	Turnips, cabbage, squash
3.0	Gooseberries	5.3	Parsnips, beets, watermelon
3.1	Prunes, apples, grapefruit (3.0 to 3.3)	5.4	Sweet potatoes, bread
3.2	Rhubarb, dill pickles	5.5	Spinach
3.3	Apricots, blackberries	5.6	Asparagus, cauliflower
3.4	Strawberries, lowest acidity for jelly	5.7	Beans
3.5	Peaches	5.8	Meat, ripened
3.6	Raspberries, sauerkraut, oranges	6.0	Tuna
3.7	Blueberries, oranges (3.1 to 4.1)	6.1	Potatoes
3.8	Sweet cherries, olives	6.2	Peas, mushrooms, cantaloupe
3.9	Pears	6.3	Corn, oysters, dates, honeydew melon
4.0	Acidophilus milk	6.4	Egg yolk, rice, wild rice
4.1	Mangos	6.6	Milk (6.5 to 6.7)
4.2	Tomatoes (4.0 to 4.6)	6.9	Shrimp
4.3	Mayonnaise	7.0	Meat, unripened
4.4	Lowest acidity for processing at 100°C, 212°F	8.0	Egg white (7.0 to 9.0)

The acidity of a food is very important in food preservation. Pathogenic bacteria, particularly *Clostridium botulinum* (the cause of botulism—see section below), do not grow when the pH is 4.6 or below. Foods that have a pH of 4.6 or lower are called high-acid foods and include fruits, tomatoes and pickles. Low-acid foods have a pH above 4.6. They include meats, poultry, fish, and vegetables. Most bacteria grow best in foods with pH values of 6.0 to 8.0. However, a few bacteria prefer, and many others tolerate, the acidity of foods having pH values from 4.0 to 6.0. Bacteria that cause human diseases (pathogenic bacteria) will not grow in highly acid foods (pH

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

below 4.6). However, some such as *E. coli*: O157:H7 can survive in acidic foods in sufficient levels to cause illness.

Time: It takes time for microorganisms to grow or multiply in foods. The time required is affected by temperature, acidity, moisture, and oxygen level. Under ideal conditions bacteria can double in number every 10 to 20 minutes.

Inhibitors: Many chemical substances prevent or inhibit the growth of bacteria. When one cleans or sanitizes, there are used products for this purpose. Some natural compounds and food additives have an inhibitory effect on the growth of bacteria. Examples include antibiotics and added preservatives. The effect of an inhibitor varies with pH, food moisture, and bacterial species.

Initial Level of Bacteria: Keeping initial bacteria levels low is important. Proper transport and handling of food, such as refrigeration and having clean surfaces and utensils, are a few ways a person can minimize levels initially.

Types of Bacteria That Cause Foodborne Illness:

Salmonella and *Campylobacter*: These two bacteria are the leading causes of bacterial foodborne illness. They live in the intestinal tracts of wild and domestic animals as well as humans (and are excreted in manure or feces) *Salmonella* can also survive for exceptionally long times in the environment. These bacteria are transmitted by contaminated foods or from an infected person. The foods involved include raw poultry and meat, eggs, and raw dairy products. It is best to assume that raw meats carry pathogenic bacteria and treat them accordingly.

Preventative controls: Cook animal products thoroughly and use good sanitation to help avoid spreading bacteria to other foods.

Escherichia coli (*E. coli*) O157:H7: When ingested, this microorganism may grow in the gastrointestinal tract and produce a toxin that may cause bloody diarrhea (hemorrhagic colitis) and/or kidney failure in some patients. The illness can be severe or fatal in high-risk persons, particularly children and the elderly. As few as 10 bacterial cells may be enough to cause disease. The bacteria can grow in the refrigerator, if the temperatures are above 45°F. Foods most commonly associated with *E. coli* O157:H7 are raw or undercooked ground beef, unpasteurized (raw) milk and soft cheese made from unpasteurized milk. Fresh produce and unpasteurized juice have also caused outbreaks. As a result the Food and Drug Administration (FDA) has warned consumers to avoid unpasteurized juices.

Preventative Control: Cook meats, particularly ground meats, to 160°F. Handle raw meats carefully to avoid cross contamination with ready to eat foods. This is one of the reasons why Cottage Food Operators are not permitted to conduct domestic activity in the kitchen during cottage food preparation. Wash produce thoroughly.

Clostridium perfringens: These bacteria are found in soils throughout the world, dust, vegetation, raw and dried foods; it is also part of the normal microbial flora of the intestinal track of humans and animals. It grows in the absence of oxygen. *C. perfringens* produce two kinds of cells:

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

vegetative and spores. Spores are very heat resistant and survive cooking. Foods most commonly involved are cooked meat and poultry, stews, soups, and gravies which have been mishandled by being kept between 60°-125°F for several hours.

Preventative Control: Cool foods rapidly and refrigerate them within 2 hours. Reheating leftovers to 165°F gives additional protection because any *C. perfringens* which grows in the food during the cooling period will be killed by the reheating.

Clostridium botulinum: These bacteria are common in soil all over the world, particularly in the western United States. The organism and its spores are widely distributed in nature. They are found in cultivated and forest soils; bottom sediments of streams, lakes and coastal waters; in the intestinal tracks of fish and mammals; and in the gills and viscera of crabs and other shellfish. These bacteria produce toxin in the absence of oxygen such as in a sealed container or below the surface of a food. The illness produced by ingesting the botulinum toxin is called **botulism**. The toxin is broken down by heat. The microorganism produces both vegetative cells and spores. The spores are very heat resistant. The foods most commonly involved are improperly canned low-acid foods (vegetables, meat, fish, and poultry), smoked fish, cooked unrefrigerated low-acid foods and some types of traditionally fermented, high protein foods.

These bacteria have the ability to form **spores** which are very resistant to heat, chemicals and physical stress. When the spores germinate and then grow, they produce the deadly neurotoxin that causes botulism. The frequency of botulism cases is rare, but each year several outbreaks occur. Many of the outbreaks of foodborne botulism in the United States have been caused by improperly home-canned foods. Vegetables, including asparagus, olives, green beans, peppers, beets, mushrooms, spinach and chili peppers, and fish are foods implicated in botulism cases. Recently a case involved home-prepared “pickled” eggs. In the United States, an average of 145 botulism cases are reported per year. Of these, approximately 15% are foodborne, 65% are infant botulism, and 20% are wound related. Adult intestinal colonization and iatrogenic botulism also occur, but rarely. Outbreaks of foodborne botulism involving two or more persons occur most years and are usually caused by home-canned foods (Sobel et al., 2004).

Several conditions are necessary for a botulism outbreak. First of all, the botulinum organism must be in the food. Secondly, the acidity level must be low. *Clostridium botulinum* cannot grow when the acid level is high. When the pH is 4.6 or less, it means the conditions are not right for the growth of *Clostridium botulinum*. Most types of *Clostridium botulinum* grow best at warm temperatures; however, growth at temperatures as low as 38°F and as high as 118°F has been observed. The organisms cannot grow if air or free oxygen is available. Oxygen-free (anaerobic) conditions occur when food is canned.

Botulism can be prevented in home-canned foods if home canners properly process foods. A pressure canner is essential for canning all low-acid foods. That's because *Clostridium botulinum* cells can form an extremely heat-resistant spore. The spore may survive boiling at 212°F. A temperature of 240°F, which can be achieved only with a pressure canner, is required to be certain that all spores have been destroyed. Home canners should follow recommended procedures and times to process low-acid foods and should make altitude adjustments when necessary because the boiling point of water changes with altitude.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

For low acid foods that are pickled, vinegar must be added in sufficient quantity to lower the pH to below 4.6. The vinegar in pickling recipes must be at least 5% acidity. When home canning, use only recipes known to provide sufficient acidity, such as those provided at extension offices or the USDA *Complete Guide to Home Canning*. Remember, however, canned low-acid foods and pickled foods *are not allowable products under the Cottage Food Law*.

Botulism has occasionally been caused by foods that were not vacuum-sealed by canning. Smoked fish can develop anaerobic conditions under the skin and in the visceral cavity. Baked potatoes wrapped in foil and meat pies have also been the cause of botulism. A large pot of sautéed onions left in a warm place resulted in botulism cases. Garlic in oil also caused more than one outbreak. Pickled eggs left at room temperature developed botulism in the yolk, which had been pricked with a toothpick, before the acid pickling solution was able to equilibrate throughout the egg.

Botulism symptoms include difficulty in swallowing, speech, and respiration and double vision. Respiratory failure may cause death. Before 1950, fatality rates from botulism were about 50%, but with availability of antitoxin and modern respiratory support systems, the death rate has decreased to about 10%. Additional information on botulism can be found in FDA's *The Bad Bug Book*.

Preventative Control: Follow reliable instructions for time and temperature for home canning low-acid vegetables, meat, fish, and poultry. Boiling food for 10 minutes or heating in the oven to 185°F will destroy the toxin if present in canned food. Refrigerate cooked low-acid foods promptly.

Staphylococcus aureus: This microorganism is found in the nose, throat, hair, and skin of 50% of healthy individuals and some animals. It is transmitted by food handlers who transfer the bacteria from hands to food. The bacteria growing in food produce a toxin that causes illness. The toxin is not broken down by heat; thus, reheating is not effective to control *S. aureus* poisoning from the toxin. Protein-containing foods such as meats, poultry, fish, milk, salads made with meat or eggs, puddings, custards, and cream-filled pies are foods commonly involved.

Preventative Control: Avoid contamination by food handlers and keep foods below 41°F or above 135°F to prevent bacteria growth.

Listeria monocytogene: These bacteria are widespread, found in soil, vegetation, and water, and are frequently carried by humans and animals. *L. monocytogenes* can survive for long periods under adverse conditions and can grow at refrigerator temperatures. Listeriosis can be severe in high-risk persons, which include pregnant women and those who are immuno-compromised. Raw milk, soft cheese, and processed foods, such as deli meats that are contaminated after the cooking stage, are the most commonly involved foods.

Preventative Control: Cook foods of animal origin thoroughly and prevent the recontamination of cooked foods. Use only pasteurized milk and dairy products. Individuals at high risk should heat deli meats to 165°F and avoid deli salads.

Foodborne Bacteria Originating from Water: Public water supplies in the U.S. and developed countries are generally safe. Always use potable water when preparing cottage foods. Potable is legally defined and is from tested sources, check with your environmental health department about well water use.

2. Viruses That Cause Foodborne Illness

Foodborne viruses cause the majority (67%) of foodborne illness in the U.S. Viruses differ from most other foodborne pathogens because they are not capable of multiplying outside a host cell. It is only after they infect a living cell that they are able to multiply. Viruses are very specific as to the species and body tissues they infect. Therefore, viruses of nonhuman origin that may be present in food are seldom a threat to human health. Viruses that are transmitted via foods originate in human intestines and are shed in feces. Foodborne viral diseases result from fecal contamination of food. Fecal contamination may be direct, through food mishandling by infected persons. It may also occur in an indirect manner through sewage contamination of water.

Viruses that can be transmitted by foods:

- Norwalk virus (responsible for 58% of foodborne illness)
- Hepatitis A
- Poliovirus

Viruses that are not transmitted by foods:

- Human Immunodeficiency Virus (HIV; cause of Acquired Immunodeficiency Syndrome [AIDS])
- Hepatitis B
- Herpes

Preventative Control: Persons with diarrhea and other symptoms of intestinal infection should not handle food. Food handlers should wash hands carefully, especially after using the toilet. Food should be properly cooked and handled with utensils. Shellfish should be obtained from approved, inspected sources, not from fecal-contaminated waters.

3. Parasites That Cause Foodborne Illness

Parasites depend on a living host to provide food and shelter. The two major classes of foodborne parasites are intestinal worms and protozoan parasites (protozoa are the smallest and most primitive form of animal life.)

Foodborne infections caused by intestinal worms include:

- Trichinosis from *Trichinella* roundworms in pork or bear meat
- Cysticercosis from beef tapeworm
- Anisakiasis from fish roundworms

Foodborne infections caused by protozoan parasites include:

- Giardiasis from *Giardia lamblia*, which comes from fecal contamination of food, toys, and water. This infection is often associated with daycare centers and in backpackers drinking untreated water from mountain streams.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

- *Cryptosporidium*, which is usually transmitted by water. Transmission also occurs from animal feces, from food, and from person-to-person contact. Infection is self-limiting in healthy individuals. People with compromised immune systems may develop lifelong infections.
- Toxoplasmosis from *Toxoplasma gondii*. Transmission can occur through consumption of raw or undercooked meat, unwashed or uncooked fruits and vegetables, unpasteurized milk and dairy products. The parasites are also in the feces of infected cats, their cat litter boxes and soil contaminated with their feces. This infection is especially hazardous to pregnant women and their unborn children.

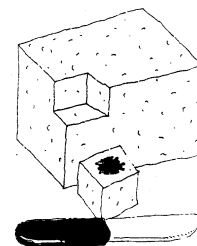
4. Natural Toxins - Molds and Their Relation to Foodborne Illness

Toxins produced by molds are called mycotoxins. Some types of mycotoxins cause cancer in animals. Mold growth and toxin production are favored by warm temperatures and high humidity.

Aflatoxin, a type of mycotoxin, is a potent liver toxin in all animals in which it has been tested. Of all the mycotoxins, aflatoxin is of greatest concern because it is highly toxic and potentially carcinogenic. Peanuts, corn, and cottonseed are the U.S. commodities that are most susceptible to contamination with aflatoxin. The Food and Drug Administration monitors foods for the presence of aflatoxin.

Mold inhibitors (preservatives), such as potassium sorbate and calcium propionate, will delay mold growth in foods. To avoid mold toxins:

- Wrap foods to exclude air
- Refrigerate cheese and fermented dairy products
- Discard all moldy foods except hard cheeses



Toxins Naturally Occurring in Foods: Since earliest times, humans have used plants for food. Through trial and error, people have learned which plants are poisonous and should never be eaten, which ones have edible parts, and eventually, which plants could be made safe by proper preparation and cooking.

Many fruits and vegetables contain small amounts of natural toxicants that are of no concern when the food is consumed as part of a varied diet and eaten in moderation. Moldy or damaged plants may contain a higher level of toxins than normal ones. Those who like to eat unfamiliar plants collected from the wild should first learn how to prepare and cook such food safely. Be cautious in the use of herbal medicines, herbal teas, and other plant mixtures that may have limited testing for safety.

Fish and shellfish may accumulate enough toxins from algae to make them unsafe to eat. The two types of shellfish poisoning which occur in west coast shellfish are paralytic shellfish poisoning and amnesic shellfish poisoning (also called domoic acid poisoning). Shellfish are monitored for accumulation of algae toxins. If the toxins are found, the waterways are closed to shellfish gathering.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

CHART 4 - Natural Toxicants in Plants

Plant of Concern	Symptoms of Illness	Cause of Problem	Directions for Safe Use
Raw, dried beans and lentils, e.g. red and white kidney beans, soybeans	Upset stomach .	Lectins—destroyed by cooking at boiling temperature or sufficient heat/time.	Soak and cook according to package instructions.
Rhubarb leaves	Severe poisoning, kidney damage (may be fatal).	Oxalic acid and anthraquinones.	DO NOT EAT LEAVES. Eat only stalks—raw or cooked.
Cassava	Breathing difficulties, staggering, paralysis (may be fatal) Long-term effect: goiter.	Contains substance that releases cyanide.	Follow traditional methods of preparation. DO NOT EAT RAW.
Peach, apple, cherry, plum, apricot seeds, shoots, and twigs	Breathing difficulties, staggering, paralysis (may be fatal) Long-term effect: goiter.	Contains substance that releases cyanide.	Eat only fleshy part and skin of fruit—raw or cooked.
Comfrey leaves (used as a vegetable)	Long-term concern: may cause cancer.	Toxic alkaloids.	DO NOT EAT.
Bracken fern	Loss of appetite, constipation, numbness. Also long-term concern: may cause cancer.	Thiaminase—substance that destroys thiamine (Vitamin B ₁); unidentified carcinogen.	DO NOT EAT BRACKEN FERN. EAT ONLY OSTRICH FERN (fiddleheads). Buy commercially.
Potato sprouts, vines, or green potato tubers	Bitter taste causes burning sensation in mouth, stomach upset, vomiting, headaches.	Solanine and other alkaloids concentrated: just beneath skin at “eyes” of tuber where green not destroyed by heat but can be reduced by peeling.	Eat tuber (potato) only; discard green portions.
Tonka bean	Long-term concern: may damage liver. Prohibited as a food additive.	Coumarin.	DO NOT EAT. Tonka bean is sometimes used instead of vanilla beans in inexpensive "vanilla" extracts sold in Mexico. Avoid use of bargain "vanilla" purchased in shops in Mexico.

5. Pesticides and Environmental Toxins That Can Contaminate Foods

Consumers are more aware today than ever before of the contaminants that may become a part of our food. Many of these substances act as carcinogens, toxins, or hormone disrupters. These include, but may not be limited to:

- Lead
- Methylmercury
- Polychlorinated biphenyls
 - Dioxin: hormone disruptors like dioxin, atrazine, lindane, styrene, lead, cadmium, mercury, PCBs, nonylphenol, and perchlorate

Exposure to pesticides and environmental toxins may be minimized by:

- Consuming organically produced foods
- Washing fruits and vegetables with running water
- Using only potable water and not risk using well or spring water
- Obtaining seafood from reliable sources
- Not cooking in plastics. Heating plastics may volatilize toxic or carcinogenic compounds

Prevention of Foodborne Illness: Food Handling Guidelines

The food industry uses the Hazard Analysis and Critical Control Points (HACCP) method as a preventive approach to food safety. Food processors, retailers, and food service establishments monitor the steps—the critical control points—where something could go wrong and correct any problems that could make their product unsafe to eat.

The steps that Cottage Food Operators can take to control foodborne illness can be divided into five major themes, which are:

- Practice Personal Hygiene and Effective Cleaning Techniques
- Avoid Cross-Contamination
- Cook Foods Adequately
- Keep Foods at Safe Temperatures
- Avoid Risky Food and Water

1. Practice Personal Hygiene and Effective Cleaning Techniques

- **Keep hands clean.** Wash hands frequently with soap and warm water and especially after using the toilet, changing a diaper, or petting an animal, and before handling food or eating food. Also wash your hands after contact with raw poultry, meat, seafood, or other foods that are likely to be contaminated with pathogens. It takes at least 20 seconds to wash hands thoroughly. A fingernail brush is helpful to clean under nails and cuticles. Dry your hands with a paper towel or a cloth hand towel that is changed at least daily. The use of gloves in food preparation is very common now. Gloves should be washed or changed every time you would normally wash your hands. If not used properly, gloves do little good.
- **Bandage any cuts** or burns on hands before handling food. Keeping disposable latex gloves at home for emergencies is a good idea. *Staphylococcus aureus* can be transferred from an infected cut to food. Cover any cuts or sores with a bandage and use plastic gloves.
- **Keep kitchen clean and sanitary.** Wipe off food preparation areas and surfaces before beginning food preparation. This is essential for the Cottage Food Operator. Wash

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

counters, cutting boards, and sinks with hot soapy water after preparing raw meat or poultry or if meat juices are spilled. Rinse well.

- **Sanitizing** is the process of killing almost all pathogens. To sanitize kitchen counters and sinks, follow directions on product labels including allowing the sanitizer to stand for a few minutes. Sanitary means free of harmful levels of disease-causing microorganisms. A sanitizing solution is one that reduces the number of disease-causing microorganisms to safe levels. Common sanitizers used in kitchens and food-processing plants include solutions containing chlorine, iodine, and quaternary ammonium. For home use, diluted chlorine bleach (1 tbsp. per gallon of cool water) and commercial sanitizing solutions which are available.
- **Keep pests away.** Flies and rodents carry diseases. Keep unrefrigerated food covered and stored in food-grade plastic, glass, or metal containers. Wipe up spills when they occur.
- **Clean dishes and utensils thoroughly.** Either use a dishwasher or hot, soapy water if washing dishes by hand, rinse with hot water and air dry.
- **Clean cutting boards thoroughly and sanitize.** Use smooth cutting boards made of hard maple or plastic, and free of cracks and crevices. These kinds of boards can be cleaned easily. Avoid boards made of soft, porous materials. Deeply scratched boards should be sanded or discarded. Wash cutting boards with hot water, soap and a scrub brush to remove food particles. Then sanitize the boards by putting them through the automatic dishwasher or rinsing them in a solution of 1 teaspoon of chlorine bleach in 1 quart of water. Leave wet for 2 minutes, then rinse and allow to air dry. Always wash and sanitize cutting boards after using them for raw foods, such as seafood, meat or poultry, and before using them for ready-to-eat foods. Cottage Food Operators should have a separate set of cutting boards to use for their cottage food activities.
- **Run sponges and dish scrapers through the dishwasher** several times a week and change dishcloths daily.
- **Use paper towels** to mop up spilled juices from meat or poultry. Discard promptly.
- **To prepare a disinfecting solution** for a spray bottle, mix 1½ teaspoons chlorine bleach with 1 pint cool water. Spray countertops with the bleach solution until thoroughly wet, wait 1 minute before rinsing and drying. Prepare spray solution daily.

2. Avoid Cross-Contamination

To prevent bacteria from one food contaminating another food, do the following:

- Always wash your hands, knives, cutting boards and food preparation surfaces well with soapy water after any contact with raw poultry, meat, seafood or their juices.
- Wash your counter tops with soapy water before and after food preparation. Rinse, air dry.
- Rinse all fresh fruits (including melons) and vegetables well under running water before preparing or eating them.

3. Cook Foods Adequately

Cooking is an essential part of making foods safe to eat since foodborne pathogens are killed by heat. Most pathogens are killed when food is heated to 160°F for a few seconds. Lower temperatures for a longer period of time will also kill pathogens. To be sure that the food is thoroughly cooked, check the temperature with a thermometer, preferably with a digital thermometer.

4. Keep Foods at Safe Temperatures

If bacteria will grow and multiply in a food, it is termed a potentially hazardous food. The temperature, acid level, and moisture level of a food determines how fast the bacteria will reproduce in this food. The temperature range for bacteria growth is about 40 to 140°F. **Check refrigerator temperatures.** The refrigerator should be 40°F or below.

Foods that Require Refrigeration. The following foods are potentially hazardous; this is why they are not classified as approved Cottage Foods. However, consumers sometimes are unaware of the need to refrigerate these foods. Always refrigerate these foods:

- Bacon (unless fully cooked)
- Beans—all types of cooked beans including refried beans
- Cut melons
- Cheese (highest risk with soft cheese, but all cheese should be refrigerated)
- Eggs
- Pasta, cooked
- Pastries—meat, cheese and cream filled
- Pies—meat, fish, poultry, cream, custard, pumpkin
- Sauces—Hollandaise and similar sauces
- Soy protein—Tofu and other moist soy protein products
- Seed sprouts of all type

5. Avoid Risky Foods and Water

Some foods are frequently contaminated with pathogens and eating them is risky. The risk is highest for people who are at high risk for foodborne illness (young children, elderly, pregnant women and people who have weakened immune systems). Read the sections about risky food and water carefully in *You Can Prevent Foodborne Illness* (PNW250) to prepare yourself to answer questions on this topic. <http://cru.cahe.wsu.edu/cepublications/pnw0250/pnw0250.pdf> “Potentially Hazardous Food” is any food, natural or synthetic, that requires temperature control because it is capable of supporting rapid growth of microorganisms, the growth and production of *Clostridium botulinum* toxin, or in raw shell eggs, the growth of *Salmonella enteritidis* (FDA Food Code.)

Avoid Foods from Unsafe Sources

- Use only potable water for drinking and cottage food preparation, such as when washing, rinsing and sanitizing any equipment, any fruits and vegetables for processing, and when washing and sanitizing hands and arms.
- Avoid eating **raw** alfalfa or other seed sprouts.
- Avoid garlic and oil mixtures that are not acidified.

Basis of Spoilage and Preservation

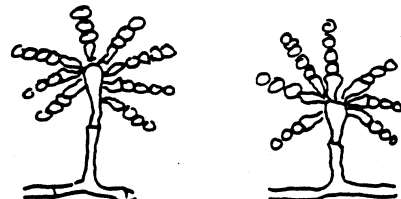
There are five general causes of food deterioration:

- Microbial Spoilage: Bacteria, Molds, Yeasts
- Enzyme Action
- Oxygen
- Insect Infestation
- Moisture Loss

1. Microbial Spoilage

The most common cause of food spoilage is the growth of bacteria, molds, or yeast that are naturally occurring microscopic organisms. Thousands of species exist in nature. When we use the term "growth," we mean an increase in numbers or population. Microorganisms only become visible when growing in masses containing millions of cells. For example, more than 25,000 of them will fit on the head of a pin! Because microorganisms are so widely distributed in the soil, water, and air, it is normal to find many types and species on the surfaces of fresh foods.

Molds—General Characteristics: Molds grow on most foods and require air and water; although, they need less water than bacteria. In appearance, their masses of growth usually are fuzzy and can be nearly any color. However, the mycelium (“roots”) of mold can spread invisibly through soft foods. Some molds produce toxins (mycotoxins) that are carcinogenic. These molds commonly grow on fruits, fruit products, grains, grain products, and some cheeses.



Molds grow best at room temperature, but some can grow (slowly) at refrigerator temperatures. They are relatively tolerant of acid and salt. This is apparent because they grow on pickles, fruits, luncheon meats, and bacon. Molds require oxygen, so wrapping food tightly will reduce the opportunity for mold growth. Molds are easily killed by heat. Most begin to die at about 140°F; almost all are dead when food temperatures reach 190°F.

What to do with moldy food? Discard all moldy foods except hard cheeses. A spot of mold growing on a soft food, such as yogurt or an orange may have spread its mycelia and possibly its toxins throughout the food.

Yeasts—General Characteristics: Yeast can grow with or without air and requires more water than molds. Their masses in or on food appear as slime, scum, or murkiness. Yeast fermentation in food is recognized by gas bubbles, froth, or foam, which result from the fermentation activity and the production of carbon dioxide gas. Depending on the specific growth conditions yeast produces acids (vinegar), alcohol (beer and wines), or carbon dioxide (raised bread) during fermentation. This can be desirable or result in spoiled food.

Yeast grows best at room temperatures and is destroyed by heating foods to temperatures of 140°F to 190°F. They grow slowly on refrigerated foods. Yeast grows best on or in acidified foods and fruits. Yeast growth in these foods can raise the pH, changing the conditions to be more favorable for bacterial growth.

2. Enzyme Action

The activity of enzymes naturally present in foods results in changes in appearance, texture and flavor, and loss of vitamins. For example, apples, lettuce and bananas all darken when cut due to the presence of the enzyme, polyphenoloxidase. When the cells of the fruit or leaf are ruptured, the enzyme is able to come in contact with colorless compounds (polyphenols) that it changes into brown or reddish compounds. Similarly, enzymes reduce the vitamin C content of freshly harvested green beans by about $\frac{1}{3}$ in 24 hours, if the beans are held at 68°F. In the first 6 hours after harvest, sweet peas will lose about 40 percent of their sugar content due to enzyme action,

if not cooled right away. Development of flavor changes, sometimes described as hay-like, bitter, oxidized, or simply old, also occur as a result of enzyme action. Bruising or crushing of raw foods increases enzyme activity and quickens the loss of quality. Enzymes are easily inactivated by quickly heating raw food to temperatures of 170°F to 190°F in boiling water, in steam, or with a microwave oven. This is the purpose of blanching vegetables before freezing or drying.

3. Oxygen

The presence of oxygen causes oxidation, which causes many color and flavor changes, including rancidity of fats. Oxygen can also increase activity of many chemical substances in food. Good airtight packaging, careful wrapping of food to exclude oxygen and vacuum packaging machines are all good ways to exclude oxygen and improve the shelf life of stored food.

4. Insect and Rodent Infestation

Some unavoidable insect eggs are contained in freshly harvested grain, vegetable seeds, herbs, tree nuts, and some fruits. If they are not controlled, the eggs will hatch and become larvae that will burrow through these foods to eat. Proper preservation steps will prevent hatching of these eggs. Unfortunately, rodents can also enter homes and find their way into stored foods. This is why all food preparation and storage areas used by Cottage Food Operations must be free of insects and rodents. Additionally, the storage of cottage food ingredients is not allowed in a detached structure because garages and storage sheds tend to have a greater likelihood for insect and rodent infestation.

To avoid stored food pests, use good sanitation. Clean up spilled foods. Store dry foods in covered containers. Glass, food-grade plastic or metal containers are more insect- and rodent- proof than cardboard or plastic bags. Buy food staples in quantities that can be used within the time periods listed in *Storing Foods at Home*. <http://4h.wsu.edu/em2778cd/pdf/eb1205.pdf>

If insects or rodents are found in food:

- Locate all infested foods and discard them.
- Clean storage areas thoroughly.
- Chemical control is not usually recommended. If problem is severe and widespread, assistance may be obtained from a reputable pest control operator.

5. Moisture Loss

Loss of moisture changes food quality. Fresh fruits, vegetables, grains, and seeds are alive. They use oxygen from the air and nutrients from their cells and give off carbon dioxide, heat, and water to continue life. These processes soften food textures and cause losses of flavor and moisture. Moisture loss proceeds more rapidly at higher temperatures. Refrigeration and proper packaging of fresh food keep these changes to a minimum.

Food Preservation on the Web

The Internet is a powerful search tool for information about food preservation. However, caution is advised because there's also a lot of misinformation on the web as well as untested and potentially unsafe recipes.

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
FOOD SAFETY

Screening Websites for Information

The end of the website identifies the type of organization that hosts the site.

- Government: .gov or .us
- Education: .edu
- Commercial: .com
- Non-profit organizations: .org

University websites are an excellent source of food preservation information. Personal websites, recipe and cooking websites may contain very unsafe recipes. Do not use these types of websites as sources of recipes for food preservation.

Some Common Questions and Answers about Food Safety

Q. Is it true that even eggs with unbroken shells can contain the bacteria *Salmonella enteritidis*?

A. Yes. While the number of eggs internally contaminated with *S. Enteritidis* is less than 1 in 20,000, there have been scattered outbreaks in the last few years. The eggs that contain the bacteria can make you sick unless properly refrigerated and properly cooked.

Q. What are the symptoms of foodborne illness?

A. Symptoms vary according to the type of microorganism involved. Most symptoms include nausea, vomiting, diarrhea, and cramps in varying degrees of severity, sometimes accompanied by fever and a headache. In some people, particularly children and the elderly, a foodborne infection can lead to severe complications and occasionally death.

Q. What is HACCP?

A. The Hazard Analysis and Critical Control Points (HACCP) method is a preventive approach to food safety. Food processors, retailers, and food service establishments monitor the steps—the critical control points—where something could go wrong and correct any problems that could make their product unsafe to eat.

Q. Are the incidences of foodborne illness rising?

A. The number of reported cases of foodborne illness has increased. The increase may be partially due to an increase in people with weakened immune systems and elderly, who are more likely to get seriously ill from foodborne pathogens. Additionally, the food industry has changed. One food producer can make large quantities of a food product that, if contaminated, can affect hundreds of people.

Q. What does sanitary mean? What is a sanitizing solution?

A. Sanitary means free of harmful levels of disease-causing microorganisms. A sanitizing solution can reduce the number of disease-causing microorganisms to safe levels if used properly. Common sanitizers used in kitchens and food-processing plants include solutions containing chlorine, iodine, and quaternary ammonium. For home use, diluted chlorine bleach (1 tbsp. per gallon of cool water) and commercial sanitizing solutions are available.

Q. Which type of cutting board is easier to sanitize, wood or plastic?

A. Both wood and plastic cutting boards will become contaminated with bacteria on contact with any raw animal product. Both types of cutting boards can transfer pathogenic bacteria from raw meat to other foods unless they are sanitized. Cottage Food Operators should have a separate set of cutting boards for their processing activities. Wash the cutting board thoroughly with soap and hot water, and rinsed well. Follow by washing the cutting board again, rinsing and drying before storing.
It is much easier to remove bacteria from plastic cutting boards because they are non-porous. A hard, non-porous cutting board such as one made of acrylic plastic is easier to keep clean than a wooden cutting board because the acrylic board can be placed in the dishwasher. Whether you prefer to use a plastic or a wooden cutting board, be certain to sanitize it after it is used for cutting up raw meat or poultry. When cutting boards develop deep knife cuts, they should be sanded or replaced.

Q. Does freezing kill *E. coli* O157:H7?

A. No. That is why it is important to cook foods thoroughly.

Q. I have a cut on my finger. Is it safe for me to handle food?

A. *Staphylococcus aureus* can be transferred from an infected cut to food. Cover any cuts or sores with a bandage and use plastic gloves. Gloves should be washed or changed every time you would normally wash your hands.

Q. How can I avoid cross contamination?

A. The ways you can avoid cross contamination are:

- Wash hands before and after handling raw food.
- Keep raw meat, poultry, and fish juices from coming into contact with other foods, especially foods that won't be cooked.
- Never chop fresh vegetables or salad ingredients on a cutting board that was used for raw meat without properly cleaning it first. Use a separate board if possible.
- Wash knives in hot soapy water after contact with raw meat or use a new one before going on to cutting ready-to-eat foods such as salad vegetables.
- Never use the same unwashed plate that held raw meat to serve cooked meat. Always place cooked food in clean dishes and use clean serving utensils.
- Use sanitizing sprays on counters and sinks.

Q. I live several miles from my favorite supermarket. How can I keep my groceries safe until I get home?

A. To protect against foodborne illness, bring an ice chest for cold food items if your trip from store to home will take more than 30 minutes. This is especially important in the summertime when even short trips can let your groceries warm up to unsafe temperatures.

Q. I want to make flavored vinegar. Where can I find information?

A. Flavored vinegars are made by adding herbs, spices, vegetables or fruits to vinegar. A fact sheet "Flavored Vinegars" is included in this binder; it has detailed instructions and is also available at www.fcs.vga.edu/pubs/current/98501.html

Q. What are the three kinds of microorganisms that can cause microbial spoilage?

A. Yeasts, molds, and bacteria.

Q. What physical and chemical processes can prevent the growth of microorganisms in food?

A. The physical and chemical process that can prevent the growth of microorganisms in food are:

- Exposure to microbiologically lethal temperatures (heat processing).
- Removal of free water (dehydrating, salting, packing with sugar).
 - Removal of oxygen and storage in air tight containers (vacuum packing must be used in combination with other physical processes like heat processing or freezing).
 - Freezing and maintaining at frozen temperatures. Refrigeration can slow microbial growth but not prevent it entirely.
- Acidifying to specific pHs will prevent or slow the growth of respective microorganisms.

References and Additional Sources of Information

- Centers for Disease Control. CDC Estimates of Foodborne Illness in the United States, 2011 <http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html>
- Food and Drug Administration. *The Bad Bug Book*. www.cfsan.fda.gov/~mow/intro.html. This handbook provides basic facts regarding foodborne pathogenic microorganisms and natural toxins.
- UCANR Food Safety Brochure -- <http://safety.ucanr.org/files/3088.pdf>
- Sobel, J., N. Tucker, A. Sulka, J. Mc Laughlin, and S. Maslanka. 2004. Foodborne Botulism in the United States, 1990-2000. *Emerging Infectious Diseases*. 10:9 (1606-1611).
- USDA Complete Guide to Home Canning http://nchfp.uga.edu/publications/publications_usda.html
- Kitchen Companion: Your Safe Food Handbook, USDA Food Safety and Inspection Service, February 2008, available online at http://www.fsis.usda.gov/PDF/Kitchen_Companion.pdf
- Chart 3: Foods and Nutrition Section, American Home Economics Association, *Handbook of Food Preparation*, 1993, 9th Edition, Kendall/Hunt Publishing Co., Dubuque, IA.
- USDA Complete Guide to Home Canning, 2009 revision. USDA AIB 539. http://nchfp.uga.edu/publications/publications_usda.html
- *You Can Prevent Foodborne Illness*, PNW250, <http://cru.cahe.wsu.edu/cepuplications/pnw0250/pnw0250.pdf>
- *Controlling Stored Food Pests in the Home*, CIS 850 <http://www.cals.uidaho.edu/edcomm/pdf/CIS/CIS0850.pdf>
- *Storing Vegetables and Fruits at Home*, EB1326 <http://cru.cahe.wsu.edu/CEPublications/eb1326/eb1326.pdf>
- PNW 250, *You Can Prevent Foodborne Illness* <http://cru.cahe.wsu.edu/cepuplications/pnw0250/pnw0250.pdf>
- Food Safety Tips for Preventing Foodborne Illness. Compiled by: Dr. Lydia C. Medeiros.

Websites

- <http://ucfoodsafety.ucdavis.edu>
- www.cfsan.fda.gov/~mow/intro.html (*The Bad Bug Book*)
- foodsafety.wsu.edu
- www.foodsafety.gov
- www.fsis.usda/thermy (thermometers)
- www.fcs.uga.edu/extension/food_pubs.php (from U. of Georgia)
- <http://foodsafety.cas.psu.edu/presqueryform.cfm> (from Pennsylvania State U.)
- <http://extension.usu.edu/coop/food/foodpub.htm> (from Utah State U.)
- <http://cottagefoods.org/laws/usa/california/>
- http://ucfoodsafety.ucdavis.edu/Cottage_Foods/
- More information is available in FSIS: *Parasites and Foodborne Illness* available on the web at www.fsis.usda.gov/OA/pubs/parasite.htm.
- American Egg Board website <http://www.aeb.org/>