Kentucky Farmers Market
Overview
House Bill 391

House Bill 391 was enacted March 10, 2003 with the intent of providing small farmers the ability to home-process foods without investing a lot of money for a permitted kitchen and permits. These value-added products may only be sold at farmers markets, certified roadside stands, or on the processor’s farm. Farmers may choose to become a homebased processor and/or homebased microprocessor, by meeting certain requirements. These requirements allow the selling of value-added products with a minimum of expense, but with food safety in mind.

The following is a brief synopsis of HB 391 as it applies to farmers becoming a homebased processor and/or homebased microprocessor.

- A **farmer** must be a resident of Kentucky and grow the primary horticultural or agronomic ingredients used in the homebased processed products they plan on selling. The food products may only be offered for sale at farmers markets, certified roadside stands, or on the processor’s farm.
- A **farm** is considered at least five acres, capable of being used for the cultivation of a garden, orchard, or the raising of fruits and vegetables. The land may be owned or leased. But the intent of this bill allows anyone who can grow the primary ingredient, no matter how small the land ownership, to be able to process value-added products.
- The **home** where the processing occurs must be the primary residence occupied by the processor. The kitchen must be designed for residential, not commercial use and there may be minimum requirements that must be met. The facility may be inspected annually by the Cabinet for Health Services. Homebased microprocessors may elect to use an existing permitted kitchen.
- The **home-based processor** is defined as a farmer who produces or processes whole fruit and vegetables, mixed greens, jams, jellies, sweet sorghum syrup, preserves, fruit butter, bread, fruit pies, cakes, or cookies. The home-based processor must make sure that the home-processed foods are neither adulterated or misbranded; that containers are clean, sanitary, and properly labeled; and that all glass containers have suitable rigid metal covers. If the product is suspect of being misbranded or adulterated, or if a complaint is registered, the local health department may sample the food product, and/or inspect the facilities. If a product is deemed to pose a threat to human health, the product may no longer be produced until the hazardous situation has been addressed to the health department’s satisfaction. Homebased processors must register with the Kentucky Cabinet for Health Services. There is no fee for the annual registration.
- The **home-based microprocessor** may use a residential or permitted kitchen to produce or process acid foods, formulated acid food products, and/or low-acid canned foods. The farmer must have an annual net income of less than $35,000 from the sale of the product. The certification process includes completion of the Homebased Microprocessor Workshop.
All foods prepared from a homebased kitchen shall have a label. Each product label should contain the following information:

- Name & Address of Operation
- Common Name of Food Product
- Ingredients, in descending order by measurement
- Net Weight & Volume
- Statement in 10 point type
  "This product is home-produced and processed."
- Date product processed

Homebased Processors and Homebased Microprocessors are prohibited from producing and marketing home processed food items that are potentially hazardous. Potentially hazardous foods which are prohibited include, but are not limited to the following: creme filled pies, custard, custard pies, pies with meringue topping; cheesecake; cream, custard and meringue pastries; raw seed sprouts; garlic-in-oil mixture; canned, pureed baby foods; and foods vacuum packaged in containers other than mason-type jars. Processed juices and food products containing meat and poultry are also prohibited.

Applications for homebased processor registration and homebased microprocessor certification are available from the Department for Public Health website at http://chs.ky.gov/publichealth/Food-Program.htm, at local health department, or from the University of Kentucky Cooperative Extension county offices. Once the appropriate application(s) is completed, the document should be mailed to the following address: Kentucky Food Safety Branch HS2E-C, Health Services Building, 275 East Main Street, Frankfort, KY 40621. The completed application can also be taken to your local health department, which will then forward the information to the Food Safety Branch.

HOMEBASED PROCESSING AND HOMEBASED MICROPROCESSING IS PROHIBITED UNTIL SUCH TIME AS THE PROCESSOR RECEIVES OFFICIAL NOTIFICATION FROM THE CABINET IN THE FORM OF A REGISTRATION DOCUMENT OR CERTIFICATION DOCUMENT THAT ALL REQUIREMENTS HAVE BEEN MET.

Registration or certification questions should be directed to Mark Reed at 502-564-7181, extension 3677 or Anita Travis extension 3718. Food preservation questions should be directed to Sandra Bastin at 859-257-1812 or your local University of Kentucky Cooperative Extension county office.
Farmers Market
Food Safety Guidelines
for Homebased Microprocessors

With the resurgence of farmers market and roadside stands in Kentucky, farmers have an opportunity to sell their produce and in-home processed foods for added income. But a good thing can turn bad quickly when customers are unhappy with the quality of their purchases or become ill from eating home-canned foods.

In recent years, fruits and vegetables have been the source of several cases of foodborne illness. *Escherichia coli* 0157:H7 has been associated with lettuce and unpasteurized juices; *Salmonella* with melons; *Cryptosporidium* with raspberries; *Listeria* with coleslaw; and *Clostridium botulinum* with home-canned green beans. Special care must be taken when handling cut raw produce and in-home processed foods. Everyone is concerned about food safety and quality. But it is the responsibility of the homebased microprocessor to make sure the foods they provide are wholesome and safe to sell.

Paying attention to three main points can help farmers market growers and vendors put food safety first.

1. Growers should use agricultural production chemicals and other products properly.
   - Follow recommended label instructions.
2. Growers should reduce the risks of potential contamination during production, harvest, handling, and processing.
   - Minimize exposure to animal waste.
   - If you are using surface, ground, or well water for irrigation, pesticide spraying, or for washing harvested produce, routinely check for unsafe levels of *Escherichia coli*. If you are not using a public water system, contact Matthew Baker with the Drinking Water Branch at 502-564-3410, extension 574. Private water supplies must be approved before you can begin processing.
   - Fields should not be used for dumping trash.
   - Equipment and surfaces used to handle fresh produce should be cleaned and sanitized as needed and then kept covered when not in use, to protect from contamination.
   - Animals should be kept a minimum of 20 feet from any food handling, processing, display; or storage.
   - Processed foods should follow strict recipe ingredients and USDA-methods. Each recipe should be approved by a Processing Authority.
3. Everyone handling or processing produce should practice good personal hygiene.
Personal Hygiene

Everyone involved in handling or processing food should understand and follow the basic principles of personal hygiene. Taking pride in the cleanliness of your appearance, your products, and where you are selling these products from, will increase consumer confidence in the safety and quality of your food products for sale.

Hand washing is perhaps the single most important activity you can do to prevent contamination of food products. But this alone does not guarantee safety of home processed foods. Hands should be washed whenever you use the restroom, anytime your hands become soiled, or upon return to the workstation after leaving it for any reason. A vigorous rubbing of hands under warm running water with soap for 30 seconds is a minimum recommendation. Hand sanitizers and moist towelettes may be used but do NOT substitute for hand washing. Waste water generated by hand or equipment washing must be disposed of in an approved manner.

Other hygiene habits include:
- do not work when you are ill
- keep yourself and clothing clean
- cover open cuts or sores
- avoid smoking, eating or drinking where food is being handled
- clean as you go, keeping all equipment and surfaces clean.

Single-use Gloves

Gloves do not eliminate the need for hand washing. They may be useful when trying to avoid barehanded contact with food, but they must be limited to a single task and then discarded when they become damaged or soiled or when your task is interrupted. Heat can melt gloves.

Controlling Food Hazards

There are three types of food hazards that may affect the safety of food, chemical (cleaning supplies, pesticides, lead), physical (jewelry; hair, glass, metal), and biological (bacteria such as *Salmonella* or *Escherichia coli*). A food hazard is defined as anything that may cause harm to someone eating the food. Paying close attention to good sanitation and manufacturing procedures can reduce the risks for contamination.

Transportation

During transportation to the site of sale, all foods must be wrapped, covered, or placed in sealed, washable containers. Processed foods should be protected to prevent damage to the seal or glass breakage. The vehicle used to transport foods should be clean and cool.

Wiping Cloths

Wiping cloths used to clean food contact surfaces should be stored in a sanitizing solution. An approved sanitizer at an acceptable concentration should be used. Check the concentration throughout the day with a paper test strip and change as needed. Household bleach at a concentration of 1 capful per gallon is acceptable (100 parts per million). Equipment and utensils should be easily cleanable. When not in use, utensils should be stored and covered to prevent contamination.

At the Market

Fresh fruits and vegetables and nuts in their shells may be displayed in open air. However, unwrapped samples should be covered to prevent contamination from insects and dirt. Customer
sampling utensils should be single service. To avoid cross contamination, separate service utensils should be maintained. Potentially hazardous foods may not be sold at Kentucky Farmers Markets. Home canned foods that are properly processed following USDA guidelines are considered shelf stable and do not pose a public health risk. All food items should be stored off the ground.

The Kentucky Department of Agriculture offers marketing assistance to farmers. In addition, their Value-Added Horticulture Marketing Program sponsors "Kentucky Fresh." For additional information contact Janet Eaton at 502-564-0290, extension 235.

Just Remember... Food Safety First!

Prepare Any Food as You Would Prepare It for Yourself or Your Family!
Principles of Home Canning for Homebased Microprocessors

Home canning has changed greatly in the last 200 years, but scientists have found ways to produce safer, higher quality products. Using proper sanitation procedures and research-based recommendations can help tasty products become a reality without the risk of foodborne illness. Food must be preserved so it will not spoil. Canning is a method of preserving food in airtight, vacuum-sealed containers with a sufficient heat process to allow extended safe storage of the canned foods. High temperature and/or pressure destroys microorganisms and inactivates enzymes that can cause spoilage and foodborne illness.

There are four keys to producing safe, good tasting products. Attention to detail will prevent you from making costly mistakes during the processing of your products.

1. **Select good quality ingredients and foods.** Foods should be free of bruises, insect-damage, diseased spots, or mold. For peak quality, preserve foods within six to twelve hours of harvest.

2. **Always thoroughly wash and trim produce.** Wash hands, equipment, and work surfaces before any preparation begins.

3. **Use research-based recipes and methods for canning all foods, whether they are low acid or high-acid foods.** Low acid foods have a pH value higher than 4.6 and include all fresh vegetables. Red meats, seafood, poultry, and milk are also considered low acid foods but are not included in the homebased microprocessing regulations. The acidity in these foods is insufficient to prevent the growth of the bacterium *Clostridium botulinum*. Low acid foods should be processed in a pressure canner or other appropriate retort system. Acid foods have a pH value of 4.6 or lower and include fruits, pickles, sauerkraut, jams, jellies, fruit butters, and tomatoes acidified with lemon juice. These may be processed in a boiling water canner.

4. **Use appropriate equipment, jars, and self-sealing lids designed for home canning.**

**Home Canning Basics**

Food spoilage microorganisms are everywhere. Almost all raw ingredients support food spoilage microorganisms. These microorganisms are alive, but die quickly if environmental conditions are not perfect. Like humans they need to eat and breathe. Home canning allows us to apply a high enough temperature for a sufficient amount of time, to kill the microorganisms present on the food. The resulting sealed container prevents recontamination of the food.
If we kill these microorganisms, we reduce human health risks and increase the shelf stability of our canned foods. Commercial sterilization (FDA) or shelf stability (USDA) is achieved when a high enough heat is applied that kills microorganisms in the food that are capable of reproducing during non-refrigerated storage and distribution conditions.

**Scheduled Process**

A scheduled process or process schedule provides a commercially sterile or shelf-stable product. A scheduled process is a detailed procedure for a single product that is issued by a recognized Process Authority. The process may include the recipe formulation; critical control points, such as the initial product temperature, the process temperature, and process time; the preparation procedure; storage, distribution, and selling. Other critical factors may need to be included in the process, such as characteristics of the product, the container specifications, or the processing equipment to be used. The scheduled process documents the safety of your recipe and alerts you to potential safety concerns during preparation and processing. It also helps you determine what records are appropriate to keep.

Most proper temperature and length of processing time has been determined by research in the canning industry, or by USDA led studies. The procedure for the process is determined by the nature of the product, the dimensions of the container, the details of the thermal processing methods used, and knowledge of the growth and survival characteristics and thermal resistance of the contaminating microorganisms. A processing authority has the expert knowledge of thermal processing requirements and adequate facilities to determine the safety of your recipe. Any changes in your recipe or methods may require an amendment to an existing scheduled process. If the changes are significant, you may need a new scheduled process.

**Acidified Foods and Formulated Acid Foods**

Acidified and formulated acid foods depend on their acidity to prevent spoilage. But acidified products may also be processed in a pressure canner for a specified period of time. The process is based on the heating rate of the product.

**Thermal Processing Methods**

Conventional thermal processing involves processing products packed in hermetically sealed containers. Most products are filled into containers that are sealed and then processed in some type of retort or pressure vessel, known as a pressure canner.

Pressure canners have established operating procedures, developed by a processing authority or the equipment manufacturer. Pressure canner operating procedures are designed to provide uniform temperature distribution throughout the pressure canner.

Before proper processing can occur, an elapsed time between the start of the heating and the start of the process or come-up-time must occur. Process timing begins only after the pressure canner reaches the correct processing temperature and when other required operating procedures have been completed. Since most pressure canners use steam as the processing medium, the air must be removed or vented, from the pressure canner before beginning the timing process. Venting allows the escape of air, which is a less efficient heating medium than steam. As steam condenses in the enclosed pressure canner, it gives off heat. This can best be explained by comparing the effect of putting your hand in a dry heat oven at 250°F or in the steam coming from a pot of boiling water at 212°F.
Home Canning Procedures

- Select good quality ingredients and produce. Produce should be free of bruises, insect-damage, diseased spots, or mold.
- Clean, trim and wash produce thoroughly. Wash hands, equipment, and work surfaces before any preparation begins and as needed.
- For peak quality, preserve produce within six to twelve hours of harvest.
- Use research-based recipes for canning all foods whether they are low acid, acidified, or high acid foods.
- Process low acid foods, with a pH of higher than 4.6, in a pressure canner or other appropriate retort. This includes all fresh vegetables and low acid tomatoes.
- Process acid foods with a pH of 4.6 or lower in a boiling water canner. This includes fruits, pickled vegetables, sauerkraut, jams, jellies, and tomatoes acidified with lemon juice.
  - Know your altitude or elevation. Kentucky communities are below 2,000 feet.
  - Before the beginning of each season, check gaskets for seal integrity and gauges for pressure accuracy. If you have a Presto pressure canner, the test kitchen will perform gauge accuracy tests for a fee or you can purchase a gauge tester. They can be reached at 715-839-2121.
  - Use jars designed for home canning with self-sealing lids. Sterilize all jars for jams, jellies, and pickled products processed for less than ten minutes. Process times over 10 minutes do not need to be sterilized. To sterilize jars follow these steps.
  1. Place empty jars right side up on the rack in a boiling water canner.
2. Fill canner and jars with hot (not boiling) water to one-inch above rims.
3. Boil for 10 minutes at altitudes less than 1,000 feet and one additional minute for each additional 1,000 feet elevation.
4. Remove and drain hot, sterilized jars one at a time.
5. Save hot water for processing filled jars.

Clean, empty jars used for fruits and vegetables to be processed in the pressure canner do not need to be sterilized beforehand. It is also unnecessary to sterilize jars for fruits, tomatoes, and pickled or fermented foods that will be processed ten minutes or longer in a boiling water canner. However, the jars do need to be washed with soap and water and rinsed.

- Fill jars with the product. Remove air bubbles with a plastic utensil. Adjust the headspace per recipe. Wipe down the rims and sides. The headspace is the unfilled space between the food or liquid in a jar and the top edge of the jar. The headspace allows for food expansion as the jar heats and for forming a vacuum as the jar cools. Assemble the lid by placing the sealing compound under the metal lid next to the jar rim. Tighten the metal screw bands securely, but not too tight.

- Process acid foods in a boiling water canner for the correct amount of time called for in your USDA-approved recipe or as indicated by your process authority. Start by filling the canner halfway with water. Preheat the water to 140°F for hot packed foods. Load jars into the canner rack or fill the canner, one jar at a time. Add more boiling water until the water level is one to two inches above the jar lids. Turn the heat to the highest position until the water boils vigorously and then set a timer for processing the food. The start time begins when the water begins to boil. Place the lid on the canner and lower the heat setting to maintain a gentle boil. If needed, add more boiling water to keep the water above jars. If at any time, the water stops boiling, the process timing must be started again. After boiling the recommended time, turn off the heat and remove the canner lid. Remove the jars and place on a towel. Leave two inches between the jars to allow them to cool.

- Process low acid foods in a weight-gauge or dial-gauge pressure canner for the correct time called for in your USDA-approved recipe or as indicated by your process authority. Place two to three inches of hot water in an approved pressure canner. Place filled jars on the rack. Fasten the lid securely. Leave the weight off the vent port or open the petcock. Heat at the highest setting until the steam flows from the petcock or vent port. This venting or exhausting allows the removal of air from within and around the food from the jars and from the canner. Maintain the high heat setting and exhaust or vent stem for ten minutes. Place the weight on the vent port or close the petcock. The canner should pressurize during the next three to five minutes. Begin timing when the weight starts to jiggle or rock, or when the pressure gauge reads the correct pressure. Regulate the heat for a steady rocking or jiggling motion or for a proper dial gauge pressure. When the designated process time is completed, remove the canner from the heat. Do not force cool the canner. After cooling, open the vent port and wait two minutes. Then open the canner, lifting the lid away from you to prevent burning yourself. Cool the jars slowly. Do not retighten the jar lids. After twelve to twenty-four hours, remove the screw bands and test the jar seals. Press the middle of the lid, checking for no spring, or hold the jar at eye level and check for a concave surface.

- Label and date all jars.
- Record pertinent information.
- Store sealed jars in a cool dry place.
- Transport jars or cans in such a way as to prevent breakage of glass, or loss of seal integrity.
Microbiology of Home Canned Foods for Homebased Microprocessors

The History of Canning
Nicholas Appert, a French confectioner, placed food in glass bottles and jars, sealed them with corks and heated them in boiling water. He was unable to explain why this method worked. Most of his work remained unnoticed until Louis Pasteur began to study microorganisms that caused fermentation and decay. Pasteurization bears his name because of these early food preservation experiments. Research in food microbiology began at the Massachusetts Institute of Technology and concluded that the spoilage of canned foods was because of an inadequate heat process to destroy spoilage microorganisms. Since then, the science of microbiology has evolved to include the study of living organisms that are unseen by the human eye.

The Microbiology of Food Processing
All raw foods contain microorganisms that will eventually cause spoilage in food unless they are controlled. Knowing the characteristics of bacteria and what environment they flourish in is the first step in controlling them. The biological hazards of mold, yeast, and bacteria are the organisms of concern in food processing. Microorganisms can be identified by their visual appearance in colonies, the nutrients that they use as food, their food spoilage by-products, and their tolerance to an environment. Microorganisms will only grow under certain conditions. When we know these conditions, we can successfully apply the right amount of heat for the right amount of time to reach the center of the container and kill any bacteria that might be present.

Today's home canning is not complicated, but it does take attention to details and a desire to follow food safety guidelines to produce a safe good quality product. The procedure involves applying heat to food in a closed jar to interrupt the natural decaying that would otherwise take place without a thermal process being applied. Following the process methods and times of up-to-date, tested home canning recipes will ensure that heat-resistant microorganisms will be destroyed. After processing and during a proper cooling time, a vacuum is formed.
inside the jar that seals the lid onto the jar. As long as the jars are stored properly and remain sealed, the home canned food should be free of spoilage and the seal prevents recontamination of food. Low acid foods have a pH value higher than 4.6 and include (Red meats, seafood, poultry, milk, soups, stews, and ragouts are also low acid foods but not included in HB391.) all fresh vegetables. The acidity in these foods is insufficient to prevent the growth of the bacterium *Clostridium botulinum*. These foods must be processed at temperatures of 240°F for a specified length of time to destroy these harmful bacteria. Boiling water canners cannot reach these high temperatures so a pressure canner must be used to process low acid foods. Acid foods have a pH value of 4.6 or lower and include fruits, pickles, relishes, jams, jellies, fruit butters, and tomatoes acidified with lemon juice. These may be processed in a boiling water canner at temperatures of 212°F for a specified time.

**Molds**

Molds are widely distributed in nature. They are made up of multicellular, tubular filaments with many cells. Molds reproduce by spores. Molds are capable of changing the pH of canned foods by consuming acids. This is important in the canning process, because acid is often used to control the growth of *Clostridium botulinum*, a pathogenic or disease-causing bacteria. Most molds cannot withstand the heat of canning so their presence signifies underprocessing or post-process contamination. Molds have been implicated in the spoilage of some canned fruit drinks, fruit and fruit-based products. Molds are capable of withstanding heat treatment because of their ability to form spores. These molds may survive 198°F in acid or acidified foods. Careful daily sanitation of equipment and supplies is important to control mold growth. However, mold growth in canned foods does not present a significant human health risk.

**Yeasts**

Yeasts are also widely distributed in nature. They are made up of unicellular, egg-shaped bodies that are smaller than molds but larger than bacteria. They usually reproduce by budding. Yeasts are usually found in liquid foods that contain sugar and acid. If spoilage does occur from yeasts, underprocessing or leakage must be suspected. Growth by yeasts produces alcohol and large amounts of carbon dioxide, which causes the seal on the lid to unseal. Yeast growth in canned foods does not present a significant human health risk.

**Viruses**

Viruses, unlike bacteria, are not complete cells but genetic material in a protein wrapper. Viruses don't increase in number while they are in food. The food and food-contact surfaces merely serve to transport the viruses, which then lodge themselves in the susceptible human host and reproduce. Once viruses gain entrance to a cell they stop its life processes and force the cell to assist in producing more viruses. Outbreaks of foodborne or waterborne viral disease are usually attributed to poor personal hygiene or a contaminated water supply. Drinking water that has not been filtered and disinfected often carries viruses. This is a very important reason for checking non-municipal water supplies.

Another water-borne microorganism of concern is the parasite. Parasites are small or microscopic creatures that need to live on or inside a host to survive.

**Bacteria**

There are thousands of identified microorganisms. Some have useful functions and others cause food borne illness when transmitted through foods. Breads, cheese, wine, beer, sauerkraut, and other fermented foods are made possible through the actions of beneficial microorganisms. A small percentage of microorganisms are pathogenic. The pathogen of greatest human health risk in canned foods is *Clostridium botulinum*. Other pathogenic bacteria, such as *Salmonella* or
Staphylococcus aureus may be present in food products that are being canned. However, since these bacteria do not produce spores, the correct heat treatment will kill these bacteria.

Bacterium is a living organism made up of a single cell. Each cell needs nutrients to live, just like humans. The bacteria live off potentially hazardous foods and multiply very rapidly at favorable temperatures. These microorganisms use food as the medium for growth and transportation to the human body. The ingestion of bacteria at certain levels can cause foodborne illness. Other bacteria produce a toxin which if ingested is usually life threatening.

### Vegetative Cells & Spores

Bacteria exist as either vegetative cells or as spores. A vegetative organism is capable of growth and reproduction. They may be resistant to low temperatures and many survive freezing. However, high temperatures kill most vegetative cells.

Some bacteria have the ability to produce a structure known as a spore. The spore serves as a means of protecting the bacteria from an unfavorable environmental condition. It can survive harmlessly in soil and water for many years. The thick wall of the spore makes it more resistant to heat, cold, and chemicals than the vegetative bacterial cell. A spore is a thick-walled formation within the bacterial cell that is capable of becoming a vegetative cell when conditions again become favorable. The spore itself does not reproduce. Because spores are so difficult to destroy, it is important to keep harmful numbers of bacteria out of the food. The environment conducive for spore germination is usually a moist, low acid food with less than two percent oxygen, and a temperature between 40° and 140°F. Because they grow only in the absence of oxygen, they are harmless on fresh foods.

Most bacteria, yeasts, and molds are difficult to remove from food. Washing fresh food reduces the number of microorganisms only slightly. Peeling reduces their numbers greatly. Blanching helps reduce the number of microorganisms off the surface of foods but is ineffective against bacterial spores. The best controls are proper methods of canning following research-based recommendations. Following the correct processing time ensures the destruction of the largest expected number of heat resistant microorganisms in home canned foods. Properly sterilized canned foods will be free of spoilage if the lid seals and the jars are stored below 95°F. Storage between the temperatures of 40° and 70°F greatly enhance the quality of the canned food.
Bacteria Reproduction

Given the right conditions, bacteria reproduce by enlarging and then dividing in two, a process known as binary fission. The two bacteria then each divide into two more cells, and so on. The result is a tremendous increase in the numbers of bacteria over a relatively short period of time.

Under ideal conditions, the growth rate for bacteria follows a pattern like the one you see here. The lag phase of bacterial growth is when bacteria adjust to being introduced into a new environment. After this adjustment time, the bacteria start to multiply very rapidly, known as the log phase. When the bacteria increase to such a large number that they begin to compete for space and nutrients, they no longer multiply so rapidly and some start to die in the stationary phase. The decline phase is when the bacterial cells begin to die more quickly due to lack of nutrients or because of their own waste products.

All these phases depend on the temperature, food supply, species of the bacteria, amount of the initial contamination, and age of the bacteria. It is important to control the bacteria so they will not grow past the lag phase. This is where you have the most control in time and temperature, which are key factors in preventing bacterial growth. As the bacteria die, they discharge waste and decompose. Even though the disease causing bacteria may be dead, the waste left behind may still make people ill.

Mobility

Bacteria move from place to place by means of water, wind, food, insects, rodents, or other animals (including human beings). Bacteria are found on the hair, skin, and clothing. They are in the mucous membranes of the mouth, nose, throat, in the intestinal tract, and on scabs or scars from skin wounds or lesions. They frequently end up on the hands and potentially in foods. Conditions that need to be ideal for bacteria to grow include food, acidity (pH), time, temperature, oxygen, and moisture (commonly referred to as Aw or water activity).
Temperature

The food danger zone is the temperature where bacteria survive and grow best. Bacteria reproduce rapidly in the danger zone range of 40° to 140°F. There are three types of bacteria that are dependent on temperature that affect the canning process. For each type of bacteria, there is an optimum temperature range for growth. Psychrotropic bacteria grow best at 58° to 68°F but they can also grow slowly in foods stored at refrigerator temperatures. Mesophilic bacteria grow best at temperatures of 86° to 98°F. Most of the microorganisms that affect food safety grow within this range. The spore forming organism, *Clostridium botulinum* is mesophilic. Both psychrotrophic and mesophilic bacteria are capable of causing food borne illness. Thermophiles are bacteria that grow at high temperatures. Spores of some thermophilic bacteria have been found to survive 250°F for more than 60 minutes. Thermophilic bacteria cause food spoilage if they are present. Since they do not produce toxins they do not affect food safety, just food quality.

Water Activity

Bacteria need a suitable food supply and water to grow. But the availability of water is the most important factor influencing growth. The measure of water available in food is designated as *A_w*. The lowest water activity value that bacterial pathogens can grow is 0.85. A measurement of water activity provides information about which microorganisms are most likely to cause food spoilage or be a threat to human health.

Controlling the water activity in foods can be used to reduce bacterial growth. Freezing, dehydrated, or mixing a dissolved substance, such as sugar or salt, in the food product, can lower water activity. When a substance is dissolved in water, that substance is attached to the water molecule. So the higher the concentration of a dissolved substance, the less water is available for bacteria to use for growth. These substances in the food product actually compete with the bacteria for available water.

Most foods have a water activity above 0.95. Most bacteria, yeasts, and molds will grow above this point. Spores of *Clostridium botulinum* are generally inhibited at a water activity of 0.93 or less. If the amount of water available to spores is decreased so that they are inhibited and also apply a heat process to destroy the vegetative cells, we have preserved the product.
Acidity Measures

Bacteria grow best in a neutral or slightly acidic medium. The pH of food is the measure of its acidity or alkalinity. A food with a pH below 7.0 is acidic and food with a pH above 7.0 is alkaline. pH is important in controlling Clostridium botulinum in home canned foods. Below a pH of 4.8, Clostridium botulinum will not grow and produce the toxin that causes foodborne illness. This is why a pH of 4.6 is the dividing line between acid and low acid foods. Spores can be found in both acid and low acid foods.

If the canned food has a water activity greater than 0.85 and a pH greater than 4.6, it is considered a low acid food. Low acid foods require a minimum heat process. If the pH has been adjusted to 4.6 or less and the water activity is greater than 0.85, it is considered an acidified food regulation and requires only enough heat to destroy vegetative bacterial cells.

Mild heat will destroy all non-sporing bacteria (vegetative cells) in acid and low acid foods. Since only vegetative cells must be destroyed in acid foods, the boiling water method procedure may be used. However in low acid foods a high heat must be used to kill the spores of Clostridium botulinum and other food spoilage organisms. As a result these foods must be heat processed under pressure, using a pressure canner. Processing under pressure for the correct amount of time is the only way to kill these microorganisms that cause foodborne illness.

Oxygen Requirements

Bacteria vary in the requirements for oxygen. Some grow only when supplied with free oxygen (aerobic). Other bacteria only grow when free oxygen is excluded or absent (anaerobic). These bacteria can grow in vacuum-sealed jars or pouches, or in a large pot of food. Some can grow in either environment. Most bacteria that cause foodborne illness grow either with or without the presence of free oxygen.

Bacterial Spoilage

There are several ways that bacterial spoilage can occur, including incipient spoilage, post-processing contamination, inadequate heat processing, and thermophilic spoilage.

- **Incipient spoilage** is food held too long before canning. This allows bacteria normally present in food to increase and start the spoilage process before canning occurs. It sometimes takes several weeks for the internal pressure to cause a loss of vacuum. This may result in an adulterated product.
- **Post-processing contamination** or contamination with microorganisms after processing also causes a loss of vacuum from high internal pressure. Leakage may occur after several weeks as spoilage causes the lid to unseal on home canned foods.
- **Inadequate heat processing** is dangerous because the health of the consumer may be affected. The time and/or temperature specified in the scheduled process for a particular product and jar size must be followed to prevent bacterial spoilage.
The spores of thermophilic bacteria are very resistant to heat that is designed to kill mesophilic bacteria. To prevent thermophilic spoilage, the product must be properly cooled and held below thermophilic temperatures. The product must be cooled promptly after canning and should be stored below 95°F.

Indications of bacterial spoilage include an abnormal appearance of the container, an unusual appearance or abnormal odor of the food product, product mushiness or off-color, and cloudiness or other signs of abnormal conditions in the liquid portion. Non microbial spoilage can also occur. This can occur as a result of overfilling of the container, under processing which pulls a low or no vacuum, or a chemical reaction of food components with metals in the water.

Bacterial spoilage usually shows us by changes in the product that it is no longer safe to eat. Low acid foods contaminated with foodborne illness causing bacteria or toxins are usually unseen. It is extremely important to not taste home canned low acid foods until they are boiled for ten minutes. Following USDA approved recipes and processing recommendations will reduce the risks of foodborne illness from low acid foods.

**Home Canning Responsibility**

Regardless of the product being home canned, it is the responsibility of the home canner to protect themselves, their families, and consumers from foodborne illness that can occur as a result of bacterial contamination. Attention to proper food sanitation in the kitchen; an understanding of how microorganisms can cause spoilage and health risks; the use of proper process methods and times provided by up-to-date, tested recipes; and the use of proper equipment, will ensure that heat resistant microorganisms are destroyed.
Acidified Foods

When an acid or acid food is added to a low acid food it becomes an acidified food. The end product should have a pH of 4.6 or less and a water activity greater than 0.85. These pickled foods include acidified artichoke hearts, bean salads, and peppers or pimientos, plus marinated vegetables like beets or mushrooms, and fresh pack pickles. By definition, certain foods are excluded from coverage on acidified food products. Jams, jellies and preserves; acid foods such as food dressing and condiment sauces containing small amounts of low acid foods that have a pH that does not significantly differ from that of the predominant acid or acid food; naturally acid foods like peaches apples, or oranges; and foods stored, distributed, and retailed under refrigeration are not considered acidified products. Foods that are preserved by microbial fermentation are not considered acidified.

Proper acidification is necessary to prevent the growth of *Clostridium botulinum*. Low acid foods are dependent upon heat processes under pressure to destroy *Clostridium botulinum*, while acidified foods depend upon the pH of the food to prevent this organism from growing. The final pH of an acidified food must be 4.6 or lower to prevent the growth of *Clostridium botulinum*. A process deviation has occurred if a product is found to have a pH greater than 4.6.

Most foods have the ability to resist changes in pH. This buffering capacity varies from food to food and will affect the amount of acid required to lower the pH of a given food by a given amount. Foods high in proteins, such as meat, have a greater buffering capacity than vegetables in brine. Therefore meat would require more acid than vegetables to lower the pH the same amount.

The recommended method for determining pH is the use of a pH meter. Inexpensive digital pH meters are available. These meters should be operated in accordance to the manufacturer's instructions. Meters should be used anytime pH is specified as a critical factor for a scheduled process. However, pH paper may be used as an indicator if the product has a pH of 4.0 or less. pH paper only gives an approximate pH value and should not be used for routine measurement of the pH of foods, unless the pH is 4.0 or less.

Most acidified home canning recipes call for direct batch acidification. This is the best way to acidify most home canned products. The ingredients are mixed in a pan and the acid is added directly to the food product. Heating the product first usually improves the rate of acid penetration into the food ingredients. The pH is checked before the food product is placed in the jar. Adding acid food ingredients to low acid foods in controlled portions is also an acceptable method of acidification. A formulated product such as zucchini with tomato sauce is a good example. The zucchini is a low acid food, while tomato sauce is an acid food. The acid food is mixed with the low acid foods in proper predetermined proportions to obtain a uniform and accurate pH of the finished product. Directly adding a predetermined amount of acid to individual containers during production is acceptable but not very accurate. Each method requires a certain amount of control in order to acidify a specific product properly.
HB 391 Farmers Market Regulations

Farmers producing acidified foods must file a scheduled process for each acidified food in each container size. Included in the schedule process should be the conditions for heat processing and the control of pH, salt, sugar, and the preservative levels. Also required is the source and date of the process. The canned products should not be sold to the public and should be destroyed if any process deviation, spoilage, or contamination of public health significance occurs. Only persons who have been certified to become a microprocessor may process acidified food products.

Whether a food should be processed in a pressure canner or a boiling water canner depends on the acidity of the food. Acid foods contain enough acid to block the growth or destroy Clostridium botulinum, the bacteria of public health concern in home canned foods. Acid foods have a pH of 4.6 or lower. The acidity of an acidified product is as important to its safety as it is to taste and texture. White or cider vinegar used to acidify a product should be 5% (50 grain) acidity. Lemon juice or citric acid may also be used to acidify food products. Although tomatoes are usually considered an acid food, some varieties have a pH above 4.6. These should be properly acidified before processing in a boiling water canner.

Critical Control Points

♦ Every container of food must be acidified in the same proportions as specified by the scheduled process. This provides consistency and a finished product with a pH of less than 4.6.
♦ The pH of the product should be measured and recorded before it is processed.
♦ The scheduled heat process should also be monitored in order to destroy vegetative cells of microorganisms of public health significance.
♦ Finally, the container should be handled with care to minimize seal damage and prevent product recontamination.