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What is a Preserved Food Process Evaluation?

A Preserved Food Process Evaluation is a service offered to food processors by the Food
and Agricultural Products Center at Oklahoma State University in Stillwater, Oklahoma. This
service exists to offer a scientific evaluation and opinion regarding the appropriateness and
safety of a food preservation process. Please note that the opinions rendered do not possess any regulatory force. The Food and Agricultural Products Center is not in any way an enforcement agency. Regulatory agencies may request or require that a food processor obtain an official opinion from a Recognized Process Authority. The Food and Agricultural Products Center is pleased to serve in that capacity when requested.

What Types of Food Products Should be Evaluated?

Food products that are likely to support the growth of harmful microorganisms if not properly preserved are candidates for evaluation. Fresh products and dry bulk foods such as cereals and spices are excluded. In general, if a food is “canned”, that is if it is sealed in an airtight, or hermetic, container and is sold and kept at room temperature, then it should be evaluated. Examples of hermetic containers include cans, jars, and some types of bags. “Acidified” canned foods (e.g. pickled vegetables) should always be evaluated. “Formulated acid” foods (e.g. most jams, jellies, preserves, canned fruits, and so on) generally do not need to be evaluated. (More information on the difference between acidified and formulated acid foods is provided below.) Dried products such as dehydrated fruits or vegetables or beef jerky should be evaluated if there is any question about the presence of residual moisture that could allow spoilage to occur. Refrigerated and frozen foods that are kept cold until prepared and eaten generally do not require evaluation. Producers of these types of food products may choose to have an evaluation done for their own information.

How Do I Have a Food Product Evaluated?

The procedures and costs for this service are detailed in the sheet entitled Procedures for Preserved Foods Process Evaluation. Briefly, we need sample containers of food for testing. We also need relevant processing information, for example cooking method and cook times.

What Will an Evaluation Tell Me?

In a nutshell, the process evaluation will examine food samples in order to categorize the type of food and determine the type of processing needed and whether the preservation process actually employed is adequate to insure a safe and wholesome food. In other words, the testing will tell you what kind of processing a food product needs and whether or not the samples provided have been safely and properly processed.

Tests Performed as Part of the Evaluation.

The products will be tested for container integrity and vacuum if applicable. Chemical tests, including pH and water activity as needed, will also be conducted. Formulation information, a general listing of ingredients and their percentage by weight in the final product, will be used along with container type, fill weight, cooking, drying, and/or added preservative information to reach final conclusions about the preservation process.

When to Expect Results and What Results to Expect.

Evaluation, excluding any microbial analysis needed, will typically take 4 to 6 weeks following the receipt of the food samples. When all testing is finished, a formal letter, referred to as a “Process Authority Letter”, will be sent. This letter gives the results of the testing and presents an opinion regarding the safety and appropriateness of the food product’s
preservation process. This letter will serve to document the review of your preservation process by a Recognized Process Authority. Such a letter may be required or requested by regulatory agencies.

**Some Basic Principles of Food Preservation.**

*Microbial Spoilage.*

It is well known that most foods, however fresh and wholesome, will go bad over time. The length of time required and the sort of spoilage likely to occur will vary with the type of food, method of preparation, conditions of storage, and so on. Some foods merely become unpalatable as they spoil, others will turn deadly. The most common, rapid, and troublesome types of spoilage result from the presence and/or growth of microorganisms in foods. These microorganisms are typically yeast, molds, bacteria, and sometimes viruses and other parasites. Several preservation techniques, some ancient and some quite recent, have evolved to slow or stop this spoilage. All rely on certain basic principles to control microbial growth. Following are factors that are important in controlling the growth of microorganisms in food:

*Methods of Controlling Microbial Spoilage.*

**Chemical Preservatives.**

These may be added directly, for example Sodium Benzoate to inhibit bacterial growth. Many spices also contain components that act as preservatives. The process of smoking a food also deposits chemical compounds that help stop microbial growth.

**Controlled/Modified atmosphere.**

Some foods are packaged in containers which control the transmission of atmospheric gases such as oxygen and carbon dioxide. These may be flushed with an inert gas like nitrogen prior to sealing. The atmosphere in the package may also change during storage as a result of chemical or metabolic processes in the foods. Fresh produce, for example, will respire during storage and this may result in lower levels of oxygen and higher levels of carbon dioxide. Many microorganisms are sensitive to the type of atmosphere around them; controlling or modifying this atmosphere will help to control their growth.

**Hermetically Sealed Containers.**

This refers to a container that is sealed against the passage of microorganisms into or out of the container, for example a can or glass jar. In essence, this means an air and water-tight package. Such a container will prevent microorganisms from spoiling a food. Of course this assumes that any microbes that were present in the food prior to sealing the container have been killed by a subsequent processing step.

**pH.**

This is a direct function of the amount of free hydrogen ions present in a food. These ions are released by acids in the food so one might think of pH as a measure of free acidity. It is these ions which give a sour taste to acid foods. Microorganisms are sensitive to the pH of a food. One bacteria in particular, *Clostridium botulinum*, produces spores that will
not grow if the pH of a food is 4.6 or less. This has great significance in how a food is processed.

**Measuring pH.**

The pH of a food may be measured in various ways. If the pH of the food is low – 4.0 or less – then the pH may be monitored using indicator papers. These contain a chemical dye that changes color depending on the pH of the solution into which it is dipped. The color of the strip is typically compared to a color chart to give an approximate pH for the sample. It is important to use the proper type of strip with this method; different strips are made for different pH ranges.

When the pH is in a more critical range, between 4.0 and 4.6, then a pH meter will be required to monitor the pH of the food product. This is sometimes referred to as the electrometric method of measuring pH. A variety of pH meter types exist with a wide range of costs. Prices vary depending on the accuracy, features, and construction of the meter. In general, an adequate meter will cost around $100.00 - $200.00. A nice feature to look for is automatic temperature compensation. This eliminates the need to manually adjust the meter to compensate for the temperature of the sample. Specific instructions for use and care of the meter will vary depending on the type of meter purchased. These instructions must be followed if accurate, consistent pH readings are to be obtained.

Some useful general guidelines apply to the use of any pH meter:

- Always calibrate the meter according to the manufacturer’s instructions prior to use.
- Since the pH of buffer solutions exposed to air will change over time, be sure to use freshly dispensed buffer solutions used to calibrate the meter.
- Rinse the electrode with distilled water and blot it dry between sample readings. Electrodes should never be wiped since this can leave a static electrical charge that may interfere with readings.
- Oil and grease from samples can clog the electrode. The electrode should be cleaned and recalibrated according to manufacturer’s instructions frequently if testing oily food samples.

**Temperature.**

Microorganisms have particular temperature ranges in which they will grow. For example, most – but not all – disease causing microorganisms will not grow below 45°F. Many spoilage microorganisms also will not grow or grow only very slowly. This is one reason why food lasts longer in the refrigerator. It is important to note that while undesirable microorganisms will not grow in a frozen food, often they will not be killed and will begin to grow once the food is thawed and heated.

**Water Activity (represented symbolically as \(a_w\)).**

Water activity is a measure of the free water that is available in a food. Such water is needed for microorganisms to grow. The value is a proportion, so a food with no free water at all will have an \(a_w\) of 0 and pure water will have an \(a_w\) of 1. Note that \(a_w\) is not the
same as moisture content. A food may have quite a bit of water in it that is bound up by salt, sugar, or other agents and so is not available for microbial growth.

A preserved food will employ one or more of the above microbial control techniques. These will usually be applied in combination with a processing step designed to reduce the number if not eliminate undesirable microorganisms in the food. Heat is most commonly used, but other mechanisms such as irradiation or chemical treatments may also be utilized. It is vital to avoid recontaminating the foods with microorganisms after such processing if safety and wholesomeness are to be preserved.

Vital Steps in Food Preservation.

Overall then, we may think of food preservation in terms of the following processing steps:

1. Prepare a food from wholesome ingredients under sanitary conditions with the lowest feasible numbers of undesirable microorganisms present.
2. If needed, apply a treatment, such as heating, designed to reduce if not eliminate undesirable microorganisms in the food. Apply one or more of the above listed control methods to prevent the growth of any microorganisms that might remain in the food.
3. Store and handle food in such a manner that the control methods used in step 2 are maintained until the food is consumed.

All three steps are vital if a high quality food with maximum safety and shelf-life is to be produced.

Important Considerations for Processing Canned Food Products.

One of the most important pieces of information used in the preserved food process evaluation is the processing times and temperatures for a canned food. This is critical because an improperly processed canned food may be extremely dangerous. Referring to the definitions above, we will define a canned food as any food sold in a hermetically sealed container at non-refrigerated temperatures. Just to be clear, when we discuss processing times we are not talking about the time needed to cook the food. Processing time in this case refers to the heating time needed for a canned food product to reach what is known as “commercial sterility.” We may define commercial sterility as that point when any harmful microorganisms capable of growing in the food have been killed. The exact processing time for a canned food product will depend on several factors. These include the pH of the food, the thickness or viscosity of the product, the size of the food particles, the dimensions of the container, and the temperature of the cooking medium. However, there are some important rules to keep in mind.

Low-Acid versus High-Acid Foods.

A low-acid food is defined as a food having a pH of more than 4.6 and a water activity greater than 0.85. Most non-dried foods have water activities much greater than 0.85 so pH is the critical factor to consider. As noted above, the 4.6 barrier represents the pH below which the spores of Clostridium botulinum will not grow. These spores are very heat resistant and difficult to kill. As a result, if a food falls into the low-acid category, it must be pressure cooked at high temperatures for long periods of time to kill these spores. If any spores survive, they may grow in the canned food and produce the deadly toxin that causes
botulism. Examples of low-acid foods include most vegetables and meat-based foods. Because of the necessity of insuring the proper processing of low-acid foods, there are a number of rules and regulations governing their production. Anyone wishing to can low-acid foods must be registered with the FDA, have received proper training, and keep extensive records as specified by federal regulations. The canning process must also be reviewed and certified by a Recognized Process Authority.

Foods with a pH of 4.6 or below, on the other hand, are considered high-acid foods. Examples of this type of food would include jams and jellies, pickles, and most fruits. The rules concerning the manufacture of these foods are considerably less stringent because they are inherently less hazardous to produce. To be safe, such foods need only to reach pasteurization temperatures – about 185°F. These temperatures are sufficient to kill all microorganisms except for bacterial spores. Since the spores will not grow because of the low pH, the food is considered commercially sterile. A high-acid food will therefore not need the high-temperature process that a low-acid food requires. A high-acid food will typically be processed in a hot water or steam bath at atmospheric pressures – no pressure cooking is required. Another alternative for high-acid foods with a pH no higher than 4.0 is to heat the high-acid food product to above 185°F and fill it hot into jars for sealing. This popular processing technique is known as a “hot fill/hold” process. Hot fill/hold processes works well if done properly. It is important to keep in mind that in general the container must be sealed before the food drops below 180°F. For this reason, it is a good practice to heat the food to around 190-195°F before filling in order to allow time for filling and sealing. In addition, the inner surfaces of the jar, jar neck, and cap must also reach a temperature of greater than 180°F. Sometimes it is necessary to pre-heat the jars in order to insure this. If the jars and lid are not heated, it is a good practice to turn the container upside down or lay it on its side and hold it without active cooling for at least two minutes after filling and sealing in order to sterilize these inner surfaces.

The type of spoilage most often encountered in high-acid foods which have not received sufficient heating is caused by yeast or mold. This type of spoilage is easily noticed and will not usually cause serious illness if the food is accidentally eaten. However, cases have occurred in which the growth of yeast or mold has consumed natural acids present in the food and allowed the pH of the food to rise to the point where *Clostridium botulinum* grows and botulism toxin is produced. For this reason, yeast and mold spoilage of high-acid canned foods should be viewed as a potentially serious matter. Such foods with visible or suspected spoilage – even a light surface layer of mold – should be disposed of and not eaten.

*Acidified Foods and Formulated Acid Foods.*

Acidified foods are high-acid foods that contain a significant percentage of ingredients that are normally low-acid. Most vegetable ingredients, such as peppers, onions, and so on are normally low in acid. A significant percentage is typically deemed to be 10% or more. The low-acid ingredients are acidified by the presence of acid in the formula. This acid may be added directly – as in the use of vinegar for pickling – or it may result from the use of naturally acid ingredients such as tomatoes. Some acidified foods are easy to identify. All pickled vegetables clearly fall into this category. However, some foods, for example salsas, contain amounts of low-acid ingredients such as peppers or onions that make them borderline acidified foods. In such cases, one of the services provided by the Preserved Food Process Evaluation is to determine the regulatory status of such foods. A food which is deemed to be naturally acid rather than acidified is termed a formulated acid food.
based products such as most jams, jellies, and preserves are generally formulated acid foods. Please note, however, that some jellies and preserves, e.g. pepper jelly and pumpkin butter, are not fruit based but rather vegetable based. These would be considered acidified rather than formulated acid foods.

Acidified foods have a pH 4.6 or lower, therefore they need only to be pasteurized to be safe. However, they are regulated more stringently than naturally acid foods simply because any misstep in their production that reduces the ratio of acid to low-acid ingredients in the formula could result in a food with ingredients that are not sufficiently acidified. Some portions of the food could have a pH greater than 4.6. If this mistake is not caught, the result can be a deadly case of botulism. In fact this has occurred. People have become ill from pickled vegetables that did not have enough acid to sufficiently lower the pH.

For these reasons, producers of acidified foods must register their formula and processing procedures with the FDA just as do canners of low-acid foods. The equipment and record keeping regulations are less involved however. Again, as with a low-acid food, process times and procedures for acidified foods must be reviewed and approved by a Recognized Process Authority.

*How Can I Determine a Processing Time/Temperature for my Canned Product?*

In some cases, it may be necessary to develop a needed cook time and temperature to adequately process a canned food product. A canner may wish to know, for example, just how long it takes for his or her pickled product to reach 185°F in a water bath when packed in a quart versus a pint jar. Or perhaps a change in the formula for a salsa results in a much thicker product – this will in all probability necessitate a longer cook time. There are times when a standard recipe may not be enough.

For such occasions, the Food and Agricultural Products Center at Oklahoma State University has the equipment and expertise to define a processing time and temperature for a canned food product. This is done using specialized temperature monitoring equipment and software to measure the rate of heating inside a can of food during processing. The amount of time and effort needed may vary significantly depending on the type of product and container. For this reason, this service is not a standard part of the Preserved Foods Process Evaluation. Please contact Andrea Graves at the address below for information on procedures and costs.

**Finally...**

Please direct suggestions and requests for further information to:

Andrea Graves  
Oklahoma State University  
142 FAPC  
Stillwater, OK 74078-6055

Should you have other questions, please do not hesitate to call Andrea at 405-744-6071.

**Thank you!**

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