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Food Preservation, Safety, and Shelf Life Extension

Food Processing for Entrepreneurs Series

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A host of food preservation options are available. Preservation methods depend upon the food and shelf life extension required. Understanding the best way to preserve your products and their impact on consumer acceptability are key requirements to enable a business to flourish. Information in this publication briefly describes several food processing terms and preservative methods.

Food preservation is vital to safety, extending product shelf life, and maintaining the quality attributes that customers find appealing. Control of shelf life also is important in limiting product and raw material wastage by the manufacturer, thus allowing efficient and low-cost food processing.

Common Terms Used in Food Technology

Aerobic — bacteria that need oxygen for growth; some species require less oxygen than others. Not all aerobic bacteria are unwanted; some are required for food preservation i.e. those used to produce the acid that enables yogurt or vinegar production.

Anaerobic — bacteria that can grow without oxygen; in fact, oxygen can be toxic to them. These bacteria can be associated with offensive spoilage smells and colors, as well as the growth of very dangerous pathogenic bacteria e.g. *Clostridium botulinum*, which produces the deadly toxin that causes botulism.

Coliforms/*E. coli* — The presence of coliforms indicate poor personal hygiene of the staff used to prepare the product. In recent years, one strain (*E. coli* 057:H7) has resulted in foodborne illness outbreaks and deaths.

***Salmonella* Sp. —** A potentially pathogenic bacteria, especially to the young and the elderly. *Salmonella* is very infectious at very low levels of contamination. One common problem source is contaminating cooked foods with utensils, cutting boards, etc. used in preparing raw or uncooked foods.

Spoilage bacteria — bacteria whose growth in a product leads to off-flavors odors or spoilage.

TPC — is a measure of the level of microbial contamination in a food. TPC numbers can vary naturally from product to product.

Laboratory analysis

This is often used on a contract basis for the microbial testing of food products; the lab should explain the significance and implication of the results.

pH — a measure of the acidity of a food. It signifies the hydrogen ion concentration in the food (inverse logarithm of H^+ concentration). As the pH is lowered the food becomes more acid. In food preservation this is significant because a food with a pH of 4.6 or lower will not support the growth of *Clostridium botulinum*, and requires a less severe heat treatment to produce a safe, shelf-stable product.

Common methods of preservation

Preservation involves a change to the nature of a product that reduces the microbial load or limits the growth of microorganisms. Clean, high-quality ingredients are needed for effective preservation. Use of unsound raw material is economically unwise due to the losses involved and the possible negative effect on finished product quality. The exact method of preservation used is dependent on the product, its effect on product safety, and the process facility in terms of power, space, equipment and hygiene.

Canning — involves packing a food in a container (can, jar, pouch, etc.) and supplying sufficient heat treatment to kill spoilage organisms or pathogens that may be present. The process must be carefully designed for each product, and should be approved by a process authority. Any low-acid

food or acidified, low-acid food must be processed in an FDA registered kitchen and have a process on file with either the FDA or the USDA.

Pickling — a term that historically has been applied to acidified foods. If the pH of a low-acid food is lowered to 4.6 or below the spores of *Clostridium botulinum* will not germinate or produce toxin. Pickling utilizes packing the food in acid to control pathogenic and spoilage organisms. Normally a pickled product is packed with a hot, acid brine usually containing vinegar, citric acid or other food acids coupled with an airtight lid (hermetic) sealing to extend the shelf life. The product is heated sufficiently to kill spoilage organisms. Acid can also be derived from bacterial fermentation of a product before packing. Examples are salt stock pickles, salami, and sauerkraut.

Drying — involves removing sufficient moisture from the food to prevent the growth of pathogens and spoilage organisms. All organisms require moisture to live and multiply. The *water activity* A_w of a food describes the amount of moisture that is available for microbial growth. Drying requires reducing the water activity sufficiently to prevent microbial growth. The dried food should be packaged to protect it from insects, moisture, etc. Often dried foods are dried to a moisture level lower than that required for microbial stability.

Sugar — most commonly used to preserve confections and in jelly and jam manufacturing. Sugar is effective in preservation because it reduces the amount of free water available (*water activity or* A_w) for bacterial growth. Heat treatment is usually used as a means of reducing the initial microbial load. High sugar levels are needed to inhibit the growth of yeasts and molds, but a standard jelly does not have a water activity low enough to inhibit molds. Because molds require oxygen to grow, vacuum sealing prevents their growth in jams and jellies. The limited water availability for microbial growth in conjunction with the acidity of fruit restricts the growth of pathogens. Diabetic jams and jellies that use reduced levels of sugar and sugar alternatives have less reduction in water activity, rely more on the use of hot filling and acidity for preservation.

Salt — is a cheap and simple method of preservation. A salt concentration of 10 percent is sufficient to restrict the growth of *Clostridium botulinum*, but lower amounts used in conjunction with other additives or thermal processing can help control spoilage. Salt is predominantly used in the dry curing of bacon or as brine for wet curing. Trace amounts of sodium nitrite are used to enhance color and flavor of some products. Fish is salted before cold smoking, followed by vacuum packing. This can be problematic since there is no cooking stage to reduce the microbial load and so the risk of *C. botulinum* growth is higher. It is thus advisable to maintain such products with a salt content of below 10 percent in refrigerated storage.

Smoking — was originally used for meat preservation whereby surface bacteria were killed by the heat of the smoke, then prevented from regrowth due to drying and the inhibitory chemicals found in smoke. Most smoking is used today to add flavor. Hot smoking often is used to dry products. Cold smoke also can be used to gently dry the product without cooking it. It is cheaper and simpler to use smoke dips or injections, which use smoke condensate or flavors. However, they also do not have the preservative effect of hot smoking.

Common methods of shelf life extension

Shelf life extension relies on changing the storage conditions and/or the product packaging to inhibit microbial growth.

Chilling — Refrigeration only extends the shelf life by a few days, e.g. sandwiches, and requires accuracy of temperature control. As the increase in shelf life is measured in days it often is used in conjunction with other preservation methods, such as heat in the pasteurization of milk, to achieve greater shelf life. Chilling is done via a blast chiller cabinet or room, larger scale production can use spiral chillers for continuous production. Liquids can be cooled using plate or scraped surface heat exchangers. The latter can take up more space than a plate heat exchanger but can handle higher viscosity liquids.

Freezing — can be a simple process to implement and can extend the shelf life by years in some cases. Product quality is better retained with faster freezing speeds due to the smaller size of ice crystals formed. Numerous methods are available for freezing product, including blast freezing (cabinet, room, or spiral freezer, dependent on throughput), plate freezing (for blocks of meat, fish, or vegetables) or scraped surface heat exchangers for ice cream. The exact method will depend on throughput and costs e.g. a liquid nitrogen bath uses an expensive coolant but has a very high throughput and takes up less space than a tunnel.

MAP and CAP (Modified Atmosphere Packaging, Controlled Atmosphere Packaging) — As a means of extending the shelf life of produce, chilled meat, fish, dairy, or poultry, the atmosphere inside the packaging is modified or controlled to inhibit or reduce the rate of spoilage. This is an expensive process due to the heavy gauge packaging needed, the machinery setup required and the food grade gas mix used. A less aggressive version is gas flushing that has lower machinery costs but a lower throughput. These systems are used with careful temperature control (refrigeration).

Vacuum-packing and shrink wrapping — are relatively simple ways of extending shelf life by up to two weeks. It often is used for meat or fish products. Use of contaminated material, however, can lead to growth of pathogenic anaerobic bacteria. This method does have risks, especially in leaky seals or damaged packaging. If there is contamination, the spoilage may not be readily visible. **Refrigeration is required.**

Shelf-life determination

The processor legally is obliged to produce a chemically and microbially safe product. Some processors test the product shelf-life when introducing a new product or a product with an unconventional processing regimen such as minimally processed sauces or salsas. This is done by testing prepared products for a range of spoilage organisms over a predetermined time period until the levels seen exceed allowable levels. This can be costly, given the range of testing and the length of time required for testing.

Products tested for shelf life should be taken from trial production runs instead of test kitchen samples, due to the differences in production methods and environments. Some testing services offer "accelerated" shelf life testing where the product is held at above normal temperature and/or humidity. These studies are useful for testing package integrity over time, and will provide data on worse-case scenarios that may occur in product holding environments. However, these should not be solely relied upon for determining the normal shelf life of a product. Conventional thermal processes usually are more reliable and cost effective for entrepreneurs who desire to market sauces, condiments and salsas. When a conventional thermal process is used to manufacture these products there is usually not a need for expensive shelf-life testing.

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