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FOOD INDUSTRY CONCEPTS

FORMULATING ACIDIFIED FOODS

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Some products such as pickled products, salad dressings, sauces, marinades, and similar foods depend on the presence of acids to prevent spoilage. This acid may be naturally occurring from foods such as fruit juices or tomatoes, or the food may be formulated by combining acid foods with other foods to achieve the desired acidity. Some foods, such as vinegar and certain pickled vegetables may have developed acidity from microbial fermentation.

Since microorganisms which cause foodborne illness may grow in foods without enough acidity, government regulations address the manufacture of these products. Title 21 of the Code of Federal Regulations, Parts 114 and 108 (21CFR114 and 21CFR108) regulate acidified foods.

Naturally acidic and fermented foods, along with jams, jellies, preserves, and certain dressings and sauces are exempted from the provisions of 21CFR114. Generally, if a food is formulated from predominantly acid foods it meets the exemptions. If, however, the food contains a mixture of acid and low acid foods, it falls under the regulation.

ACIDITY AND pH OF FOODS

The acidity of a food is measured as a pH value. The pH scale ranges from 0 to 14 with pH 7 being neutral. Any pH below pH 7 is considered in the acid range and those above pH 7 are considered in the basic range. The lower the pH value, the more acidic the food. Table 1 lists the pH of some foods and ingredients frequently used by food processors.

Table 1. Acidity levels of selected foods. (Source FDA BBB-pH Values of Various Foods: http://www.fda.gov/Food/FoodborneIllnessContaminants/CausesOfIllnessBadBugBook/ucm122561.htm)

Acidity Levels	Food Item
Low Acid (pH greater than 5.0)	cocoa eggs milk and most cheeses sweeteners: sugar, molasses, corn syrup melons most vegetables rice and other grains seafood, poultry, red meats
Medium acid (pH 4.6 - 5.0)	bananas cottage cheese; cream cheese
Acid (pH 3.5 - 4.6)	blueberries, strawberries buttermilk oranges/orange juice pears, apricots, peaches, pineapple, apple sauerkraut honey tomatoes
High Acid (pH lower than 3.5)	cider cranberry juice jams/jellies lemons/lemon juice, limes/lime juice pickles and relish vinegar

Food preserved with acids are required to have a pH of 4.6 or below. At these levels, the production of toxins by the deadly organism that causes botulism is prevented. We refer to foods that have pH readings greater than 4.6 as low-acid foods. Most vegetables and meats fall in this category. Most fruits and tomatoes

have pH values lower than 4.6 and are considered acid foods.

Formulation of Acidified Foods

Acid foods depend on one or more food acids such as citric, malic, lactic or acetic acid to achieve stability. Most acidified foods, including dressings and sauces, use vinegar (acetic acid) to produce the desired acidity. Vinegar is used because it is an effective source of food acid and it is familiar to both producers and consumers.

When low acid foods are used in formulations, it is important that they are properly acidified before they have a chance to spoil. They must reach equilibrium pH within an adequate time. The rate of uptake of acid by low acid foods can be influenced by factors such as piece size or the presence of a waxy peel. These factors can often be overcome by reducing the piece size of the low acid food. It is important that piece size be strictly controlled to achieve uniform acid uptake. When oil is used in the formulation, low acid components should reach an equilibrium pH below 4.6 before adding the oil.

Most foods have a chemical property called buffering capacity that allows them to resist changes in pH. Greater amounts of acid must be added to the foods at certain pH levels to continue to achieve a reduction of pH. Buffering can be a useful property to prevent changes in pH with minor variations in added acid.

Measuring pH

You will need to measure and record the pH of each batch of finished product. The pH of a food is usually measured using a pH meter. Electrodes from the meter are inserted into the solution to measure the pH electronically. A variety of pH meters are available from scientific equipment suppliers. Prices range from less than $100 to over $1,000, depending on the type and the features of the meter (Figure 1).

Figure 1. Handheld and bench type pH meters.

Estimation of pH can also be obtained colorimetrically using pH test papers (Figure 2). These papers, available from scientific supply houses, can be purchased for a few dollars. Regulations allow the colorimetric monitoring of pH for foods with pH levels below 4.0. To have a built-in safety factor, acid and acidified foods are normally formulated to pH levels well below 4.6. As Table 1 shows, most acidified food have a pH below 4.0.

Figure 2. pH papers can be used for monitoring acidity levels with foods having a pH less than 4.0.

Sample Preparation

To measure the pH of a food, the food should be liquid or prepared as a puree in a blender. The liquid test sample should be representative of the whole product. Any oil layer may need to be decanted to get a measurement of the non-oil phase. To measure the equilibrium pH of a low acid food, separate the low acid portion from the acidifying portion and prepare and measure the two samples

Assuring an Accurate pH Reading

When measuring pH of a prepared sample, you should always follow the instructions of the pH meter manufacturer carefully. Regardless of the pH meter being used, the following guidelines should be followed:

- Calibrate the pH meter using two buffers – usually pH 4 and pH 7.
- Make sure the temperature compensation is set properly.
- Rinse the electrodes with distilled or deionized water between readings. Pat dry with tissue. CAUTION; DO NOT RUB THE ELECTRODES WITH THE TISSUE AS THIS WILL PRODUCE A STATIC CHARGE THAT CAN LEAD TO IMPROPER READINGS.
- Stir samples while measuring.
- Record pH only after reading stabilizes.
- Products that have a high oil content may clog the electrodes. After testing such products, clean electrodes in alcohol or as recommended by the manufacturer.
- Store the electrodes with tips submerged in distilled water or buffer as directed by the manufacturer.

individually.

Controlling Spoilage

Properly acidifying to pH 4.6 or below will inhibit the growth of most bacteria and the formation of toxins by the bacteria that causes botulism. Acidification cannot replace proper sanitation and care in manufacturing. The manufacturer must, therefore, adhere to the highest standards for cleanliness and protection of the product. The standards are covered under another regulation, 21CFR110, often called Good Manufacturing Practices.

When manufactured under proper conditions of acidification and sanitation, a food product may still be spoiled by yeasts, molds, and fermentative bacteria such as lactic acid -producing bacteria. To prevent this, acid and acidified foods are usually heated to kill yeast and mold spores in the products or they are refrigerated to prevent their growth.

Acid and acidified products are generally put into the packaging hot, called hot filling, to kill contaminants in the container. The amount of heat required to pasteurize the acidic product is dependent on the pH of the product. Products with a lower pH require a lower fill temperature since yeasts and molds are more susceptible to heat under acid conditions. The minimum fill temperatures needed to pasteurize products with different pH values are shown in Table 2. The product should be cooled before placing in cardboard cases to avoid "stack burn."

Table 2. Relationship of pH and fill temperature

pH	Minimum fill Temperature (°F)
3.9	185
4.1	190
4.2	195
4.3	205

Some products should not be heated. In these cases, preservation is achieved by refrigeration or increasing the amount of acid and/or the use of chemical preservatives. Sodium benzoate and potassium sorbate are often used for this purpose. They are often used together to take advantage of their combined effects.

Other Requirements

The potential for improper formulation in the manufacturing of acidified foods has been determined to be a public health hazard. To reduce the likelihood of foodborne illness, the acidified foods regulation requires plants producing acid and/or acidified foods must be registered with the FDA. Producers of acidified foods must also file a scheduled process for each product with the FDA. Acid foods are exempt from this requirement. The scheduled process filed must come from a recognized process authority who is qualified by training and experience to develop such a process.

In addition, persons supervising the manufacturing of acidified foods must attend an approved school and earn certification as a supervisor for processing acidified foods.

The regulation also address other important aspects of product manufacturing. These include:

- The integrity of the final container in which the product is packaged should be tested and recorded to ensure the container suitably protects the food from leakage or contamination.
- Records should be kept of examination of raw materials, packaging materials, and finished product; records verifying that you have met all critical control points outlined in your scheduled process; and records identifying initial distribution of the product. These records should be kept for three years.
- If there is deviation from your scheduled process, records must be kept addressing the deviation and how it was corrected. These records must be kept in separate files from other processing records and must be kept for three years.
- A recall plan must be established.

Labeling the Food

Regulations dealing with food labels are extensive and complicated. After you have a draft label, but before purchasing any labels, consult with experts on food labeling to assure the information on your label is correctly presented. This will avoid the cost of having to reprint labels with improperly presented information.

Where to Get Help

The Arkansas Food Innovation Center (AFIC) of the University of Arkansas System's Division of Agriculture Institute of Food Science and Engineering offers resources to assist entrepreneurs in product development. AFIC has a process authority who can assist in establishing a scheduled process. AFIC staff can also provide guidance on filing appropriate paperwork with regulatory authorities, reviewing label design and developing nutritional panel information. A Better Process Control School is offered annually to provide certification for supervisors of acidified food processing operations. For more information on AFIC, services available, and procedures for working with AFIC, please visit our website: afic.uark.edu.

The Arkansas Department of Health (ADH) has requirements that affect the processing of acidified foods. For more information on these, contact William Hastings, Senior Environmental Health Specialist (phone 501-661-2171; email william.hastingsjr@arkansas.gov).

Information on how to register your facility and file your product with FDA can be found on the FDA website (http://www.fda.gov/Food/GuidanceRegulation/

Key Considerations When Producing Acidified Foods

- Carefully formulate to assure that sufficient acid is added to reach the desired pH below 4.6.
- Monitor the pH and formulation carefully. Keep good records on each lot produced.
- Produce the food using Good Manufacturing Practices as defined in 21CFR110.
- Contact an acidified foods processing authority to develop a scheduled process for your specific product.
- Register and properly file the scheduled process with FDA. Document that the scheduled process is followed. Deviations from the scheduled process must be recorded and corrected.
- Eliminate mold and yeast spoilage with "hot filling" and/or refrigeration or using chemical preservatives.

Material partially adapted from "Acidified Foods: Formulating Dressings, Sauces, and Marinades" prepared by John E. Rushing and Patricia Curtis, North Carolina Cooperative Extension Service and "Acidified Foods: Definitions and Regulations" prepared by Virginia Cooperative Extension Service

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