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VIRGINIA STATE

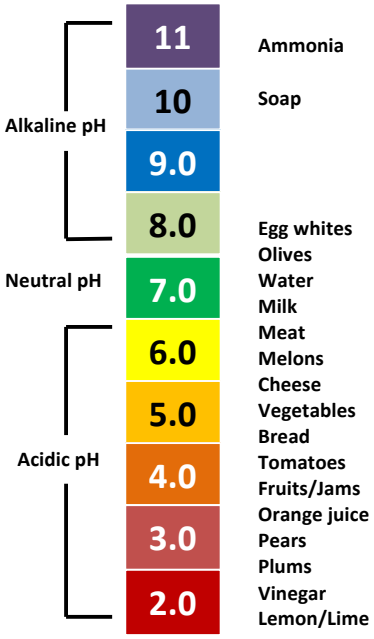
How do you know if your food is safe to sell?

Factors that Affect Bacterial Growth on Foods: FAT TOM

Preparing food at home does not guarantee its safety. If not prepared properly, microorganisms (bacteria, yeasts and molds) on the food, in the environment, or transferred by the person preparing the food, may lead to spoilage or foodborne illnesses. Food spoilage microorganisms may change the aroma, texture, and/or appearance of food. **Pathogens** (microorganisms that make you sick) do not change the food so we often do not know they are present. Practicing good sanitation and proper food safety techniques are important ways to prevent food from becoming contaminated with microorganisms. It is also important to make sure that microorganisms do not have a chance to grow within the food. Microbial growth is affected by the following six factors: Food, Acidity, Time, Temperature, Oxygen and Moisture, also known as **FAT TOM**. If you can control one or more FAT TOM factors then you can prevent microorganisms, including pathogens that may be in the food, from growing to dangerous levels that might make someone sick.

Acidity – pH

The pH of a food is a measure of how acidic it is. The pH scale ranges from 0 – 14, with 7 being neutral. Water has a pH of 7. The pH is acidic if it is lower than 7 and basic if it is higher than 7. Each pH unit actually represents a tenfold difference. For example, if the pH goes from 4 to 3, there has been a 10-fold increase in acidity. Almost all foods fall below 7 on the pH scale, making them acidic in nature. The figure to the right shows where some foods fall on a pH scale. Most pathogens can grow at pH values between 4.6 and 9.0, but very acid or sour foods (pH below 4.6) discourage the growth of many microorganisms. Foods with a pH less than or equal to 4.6 are called **high acid foods**. Examples include fruits, jams, jellies, and honey. Products may be naturally high in acid or you might acidify products by adding acid (e.g., vinegar, wine, Worcestershire sauce, or lemon juice) to lower the pH. Pickling foods (by adding acid or through natural fermentation) lowers the pH enough to discourage many microorganisms. Foods with a pH greater than 4.6 are called **low acid foods**. Examples include milk, meat and vegetables.



Time and Temperature

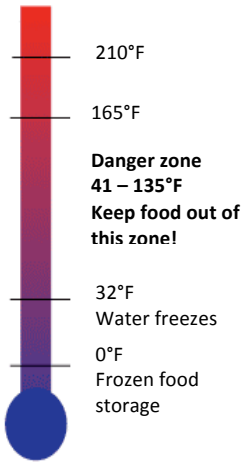
Time and temperature are very closely related in controlling microbial growth. Bacteria can double in number every 15 to 20 minutes, especially in the temperature range of 41°F to 135°F. This temperature range is referred to as the "**temperature danger zone**," because most microorganisms multiply quickly within this range. In order to control the growth of microorganisms, do not allow potentially hazardous foods to be held in the temperature danger zone for more than two hours.

Potentially Hazardous or Time and Temperature Control for Safety (TCS) foods are those that are capable of supporting the rapid and progressive growth of pathogenic microorganisms. In general, foods that have been processed and contain moisture fall within this category. Microbial growth in these foods can only be controlled using time and temperature. Controlling or altering other FAT TOM factors is not effective.

Examples of Potentially Hazardous (TCS) Foods

- Milk and dairy products
  - Cheese
  - Sour Cream
  - Whipped Butter
- Meat and Poultry
- Shell eggs
- Fish
- Poultry and poultry products
- Shellfish and crustaceans
- Foods derived from plants that are heat treated including:
  - Onions (cooked and rehydrated)
  - Cooked rice
  - Soy protein products (e.g., Tofu)
  - Potatoes (baked or boiled)
- Cut melons and cut tomatoes
- Raw seed sprouts
- Leafy greens
- Garlic-in-oil and other vegetable-in-oil mixtures that are not treated to prevent the growth of *Clostridium botulinum*
- Certain sauces, breads, and pastries containing meat, cheese, cooked vegetables

For every 10°F increase in storage temperature there is a doubling in growth rate of bacteria and for every 10°F decrease in storage temperature the growth rate is cut in half. Storing foods below 41°F will slow the growth of most pathogens extending the amount of time the food may be safely held for sale or consumption. Because pathogen growth is not stopped by refrigeration, potentially hazardous foods cannot be stored indefinitely. If potentially hazardous foods are mixed, **prepared**, handled, cut, wrapped, or packaged at a retail setting they may be stored a maximum of seven days at 41°F. The only reliable way to measure the temperature is with a calibrated thermometer inserted into the food. According to the most recent Virginia Food Code, cooked potentially hazardous foods should be cooled within two hours from 135°F to 70°F and within four hours from 70°F to 41°F or less.



Oxygen

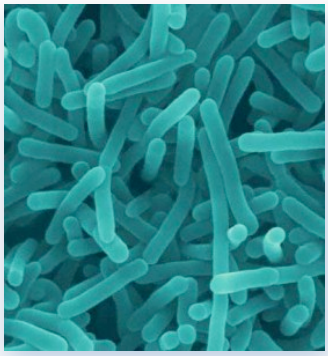
Not all microorganisms need oxygen to grow. Some prefer levels of oxygen similar to levels found in the air that we breathe. These microorganisms are typically spoilage microorganisms such as yeasts and molds. Other microorganisms cannot grow in the presence of oxygen. Then there is a third group of organisms that grow best with low oxygen. These are commonly the pathogens. Removing or reducing oxygen in food packages (by vacuum packaging or canning) or exchanging it with other gases (by using controlled atmosphere or modified atmosphere packaging) stops the growth of most spoilage microorganisms, but can encourage pathogens to grow. For example, *Clostridium botulinum* that causes botulism grows well in the absence of oxygen. If you do remove oxygen, you must control other FAT TOM parameters in order to prevent the growth of *C. botulinum*.

Moisture (Water Activity)

A measurement called water activity (a_w) provides information about amount of water in a food product. Usually water activity correlates with moisture. Water activity, also called free water, is the amount of water available for microorganisms to use for growth. There may be other water present, but in an unusable or bound form. Water activity is measured on a scale from 0.0 to 1.0, where pure distilled water is 1.0. Just like oxygen and pH, water requirements vary among microorganisms. Typically, bacteria require lots of water. When that water is taken out of the product (or bound) most bacteria are no longer able to grow. Water can be bound by adding food ingredients such as salt and sugar. For this reason, jams and jellies which have high water content have comparatively low water activity due to the higher sugar content. Drying and freezing can also be used to alter water activity and make it unavailable for microorganisms. Foods such as jams, jellies, honey, breads, and cookies that have a water activity of 0.85 or less can be considered shelf stable and do not require refrigeration. Once jams and jellies are opened, storage under refrigeration extends shelf-life.

A **foodborne illness** is any illness resulting from the consumption of food contaminated with pathogenic microorganisms; usually caused by improper handling, preparation, or food storage. Good hygiene practices before, during, and after food preparation can reduce the chances of contracting an illness.

For more information on the following FATTOM principles: ACIDITY, TIME and TEMPERATURE, OXYGEN, or MOISTURE, see individual factsheets about each factor, located online at http://pubs.ext.vt.edu/category/food-safety.html and available through your local extension agent.



10 Most Important Factors Contributing to Food-borne illnesses in the United States:

1) Improper cooling
2) Laps of 12 or more hours between preparation and eating
3) Infected persons handling foods
4) Inadequate reheating
5) Improper hot holding
6) Contaminated raw food or ingredients
7) Foods from unsafe sources
8) Improper cleaning of equipment and utensils
9) Cross contamination from raw to cooked foods
10) Inadequate cooking

For more information:

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