Lesson 2: Food Perishability

Food is a perishable commodity. The storage life, however, depends on a variety of factors as well as which food product you are considering. Egyptians stored wheat very well. Recently, some Egyptian wheat stored for more than 3,000 years was discovered. This wheat was still suitable for use as food. Other products, like fresh, uncooked meat can spoil within a few hours if left at room temperature.

Food Characteristics Influence Deterioration Rate

Deterioration rate is influenced by the characteristics of the food product. The pH, or hydrogen ion concentration, affects how long food will stay fresh. In general, foods spoil fastest when pH lies between 6 and 8 (Neutral pH is 7.0).

The moisture, or water activity level, is another important food characteristic that influences deterioration rate. All microorganisms require moisture to survive. Foods with very little water content will not support microbial growth. The water activity level of foods must be reduced to 0.6 or below to prevent all microbial growth. Foods with a water activity near .99 support microbial growth best. Moisture may be removed by heating the food or by adding salt or sugar to the food, which by the process of osmosis, removes water from the microbe's cytoplasm.

Deterioration rate is also affected by the temperature of the product. Foods deteriorate fastest at temperatures between 60°F and 100°F.

The oxygen level of the food product is another important consideration. If the oxygen has been removed from the food by vacuum packaging, the growth of molds and aerobic bacteria will be stopped, but anaerobic microorganisms may flourish.

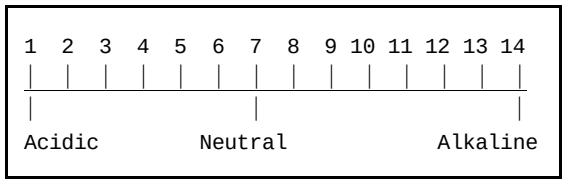
The physical characteristics of the food are also factors that influence deterioration rate. The degree of ripeness, whether immature or overmature, can have a dramatic effect on the food's perishability rate. The actual size of the product, or its surface area, is another important physical characteristic. In the case of meat, the whole carcass is less vulnerable to deterioration than steaks or ground meat because the whole carcass has less exposed surface area per unit of weight or volume. Because retail cuts such as steaks have more surface area, they provide a more readily available source of nutrients, oxygen, and water for the microbes than do whole carcasses.

Acidity/Alkalinity Influence on Perishability of Foods

The pH readings of most foods vary from about 2.6 to 7.0. Some examples are: dill pickles, pH 2.9; apples, pH 3.0; tomatoes, pH 4.2; sweet potatoes, pH 5.4; and shrimp, pH 6.9. The perishability of food products is dependent upon their degree of acidity or

alkalinity. On the pH scale of 0-14, an alkali is any substance with a pH of 7.1-14.0. An acid has a pH of 0-6.9. Alkalis have a bitter taste; therefore, very few food products are alkaline. Stored eggs and soda crackers are examples of alkaline foods.

Figure 2.1 - pH Scale



An alkaline pH reading above about 8.0 slows or inhibits microbial growth. An acid modifies or denatures bacterial protein, and some acids are directly toxic to bacteria. Therefore, the more acidic a food product is, the slower its rate of deterioration will be. Acids are natural products of citrus, apples, tomatoes, etc. Acids can also be added. In the case of pickling, acetic acid may be added. Lactic acid is the product of bacteria that is native or has been added in fermentation. Microorganisms prefer an environment with a pH range of 2.0-8.0. Bacteria favor a neutral pH, molds prefer 2.0-8.0, and yeasts prefer 4.0-4.5.

Relationship Between Water, Salt, Sugar, and Osmotic Pressure

Water is required by all microorganisms. A reduction in the amount of water available is an effective means of food preservation. All of the moisture in a food product may not be available to the microorganisms. The amount of water that is available is called water activity (Aw). When salt or sugar is added to food, the Aw decreases. This is the principle used for salt or sugar-curing meat and also for syrup, jelly, and jam making. The addition of salt or sugar increases the osmotic pressure of the food item. Osmotic pressure is defined as the force that a dissolved substance (e.g., salt or sugar) places on a semipermeable membrane through which it cannot penetrate when the dissolved substance is separated from pure water by that membrane. When the osmotic pressure in a food product is high enough to draw water away from a microbial cell or prevent normal diffusion of water into the microbial cell, the cytoplasm of that cell dehydrates. This is fatal to that microbe. The greater the salt or sugar concentration is, the higher the osmotic pressure will be. A 70 percent sucrose solution will stop the growth of all food microbes.

Microbial Activity

Microbial activity affects food preservation both physically and chemically. Physical changes of food are more apparent than chemical changes. Slime formation, undesirable odors and flavors, and color changes are all physical changes caused by aerobic bacteria and yeasts. Aerobic means in the presence of O_2. Another physical change caused by aerobic molds is a sticky surface.

Chemical changes in food caused by microbial activity include the breakdown of complex organic molecules into simpler molecules. Examples include protein decomposition into peptides and amino acids under aerobic conditions. When

anaerobic (without the presence of O_2) conditions are present, proteins are degraded into foul-smelling sulfur compounds. Non-protein nitrogen is degraded into ammonia. Microbes secrete lipases which hydrolyze, i.e., break down by adding water (H_2O), molecules of triglycerides into glycerol and fatty acids. Similarly, phospholipases hydrolyze phospholipids. This process creates a rancid flavor in food. Carbohydrates, the preferred energy source of microorganisms, are broken into organic acids, alcohol, CO_2 and H_2O, depending on the pathway the microorganism uses in metabolizing them. Lactic acid in fermented sausage is an example of an organic acid. Microorganisms, after degrading complex molecules, utilize the simpler molecules as nutrient sources for their growth and activity.

Chemical Preservatives

Chemical preservatives are substances added to a food intentionally to improve its appearance, flavor, texture, or storage properties. They are often called additives. One example of an additive is sodium benzoate, which is used to prevent microbial growth in soft drinks and acidic foods. Calcium and sodium propionates are additives used in breads and cakes to prevent mold growth. Cheese products may have sorbic acid added to control mold. Fruits and vegetables may be washed in a germicidal chlorine compound. Ethylene oxide and ethylene formate are fumigants used to control microbes of spices, nuts, and dried fruits. Sulfur dioxide (SO_2), is an additive which controls the browning of fruits and vegetables.

Many foods which contain fat become rancid by oxidation. Therefore, BHA (butylated hydroxyanisole), BHT (butylated hydroxytoluene), and TBQH (tertiary butylated hydroquinone) are used in products like potato chips to prevent oxidation. Nitrites are often used in cured meats to help prevent outgrowth of *Clostridium botulinum*. Salt or sugar used to lower the Aw and acid needed to lower the pH are considered additives. The addition of smoke, another additive, acts as a bacteriostat or bactericide.

Atmosphere Affects Food Perishability

Food perishability is affected by the gaseous atmosphere. In the absence of O_2, all molds and aerobic bacteria are controlled. Nitrogen is used in immersion freezing. Nitrous oxide is a propellant used in aerosol food cans. Carbon dioxide (CO_2) replaces the O_2 in fermented products. CO_2 is also used in soft drinks where it contributes to carbonic acid production. CO_2 and ozone (O_3), have been used in the holds of ships to prevent aerobic microbial growth. Ethylene gas speeds the ripening and color development in citrus and bananas. Eggs are stored in enriched CO_2 storehouses to minimize micro growth. The relative humidity levels in the gaseous atmosphere also affect the rate of spoilage of foods.

Summary

The deterioration rate of food is influenced by the type of product, pH, water activity, temperature, oxygen level, and many physical and chemical characteristics. The more acidic a food product, the slower the deterioration rate. The addition of salt or sugar to food will increase the osmotic pressure and lower the water activity, and hence the deterioration rate decreases. Microbial activity causes both physical and chemical changes in food. For this reason, food additives are often used to intentionally improve a food's storage properties. A wide variety of gaseous atmospheres can be used to help preserve food products.

Credits

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