Thermal Preservation Processes

Processes that employ heat to make food safe for consumption and/or extend shelf-life by reducing or eliminating microbiological contamination (pathogens or spoilage) and enzymatic activity of the food. These processes could also affect texture and flavor of food products.

Processing methods	Process description	Food Use Examples	Used at Home	Benefits	Drawbacks
Cooking/Heating	Increasing the temperature of a food and beverage product to destroy microorganisms, inactivate enzymes, preserve the food, and improve the edibility of some foods	Eggs, meat, vegetables, potatoes, cereal grains (rice, oats, wheat), and pasta	Yes	Food safety; shelf-life; impact flavor and texture of some food products	Potential loss of heat sensitive vitamin(s); changes color; impacts taste in some food products
Pasteurization	Heating food and beverage products at a specific temperature for a particular length of time	Milk, juices, some egg products, jams, jellies, and some sauces	Yes	Food safety; shelf-life	Potential loss of heat-sensitive vitamin(s); modifies protein structures
Drying	Using heated air or light (infrared, solar) to substantially reduce water content	Meat, milk, cheese and, other dairy products, egg products, grains, and fruits and vegetables	Yes	Shelf-life	Potential loss of heat-sensitive vitamin(s); changes product texture and flavor; increases calorie content due to water loss

Direct Steam Injection	Heating a liquid food product by injecting steam under pressure to achieve a particular temperature (e.g., pasteurization)	Milk, processed cheese, and other dairy products, nutrition shakes, juices and other beverages, and soups	No	Food safety; shelf-life	Increases moisture content of the food product; potential loss of heat-sensitive vitamin(s); modifies protein and fiber structures from the original state; imparts burnt flavor
Ultra-High Heat Treatment (Indirect steam heating)	Rapid heating of a product above the boiling point of water for a very short time	Shelf-stable liquid dairy products (e.g., milk and nutrition shakes), juices, and other beverages, pastes, sauces, and purees	No	Food safety; shelf-life	Potential loss of heat-sensitive vitamin(s); modifies protein structures; imparts burnt flavor
Frying	Rapid heating or cooking of a food product in hot oil (300-500 F)	Fried meat, potatoes (e.g., French fries or potato chips), fried vegetables, and eggs	Yes	Food safety; shelf-life; changes texture and color and flavor	Adds fat to the food, thereby increasing calorie content of the food; potential loss of heat-sensitive vitamin(s); modifies protein structures; could impart burnt flavor; could

					generate components that are potentially carcinogenic (e.g., acrylamide)
Baking	Heating or cooking a food product using either a batch or continuous oven at a specified temperature and time to achieve a desired temperature within the food product	Meat, breads, cakes, potatoes, vegetables, mixed dishes (e.g., casserole), and fruits	Yes	Food safety; shelf-life; imparts brown color on the surface and flavor; modifies texture	Potential loss of heat-sensitive vitamin(s); modifies protein structures; increases calorie content due to water loss
Grilling	Cooking a food product over open flame (usually 350-600 F) for a specified time to achieve a desired temperature within the food product	Meat, potatoes, and vegetables	Yes	Food safety; shelf-life; imparts favorable taste, texture, and appearance	Potential loss of heat-sensitive vitamin(s); modifies protein structures; imparts burnt flavor; generates compounds that are potentially carcinogenic (e.g., acrylamide)
Smoking	A method used to preserve meat by using salts to dehydrate the meat and cooking the meat at a lower temperature ranging between 190-250 F in the presence of smoke,	Various types of meat and some cheeses	Yes	Food safety; shelf-life; imparts unique flavor; modifies texture	Modifies protein structures in meat; could impart unacceptable flavor due to the variation in the absorption of smoky flavor

	generated by burning organic material(s)				
Radio Frequency Heating (Microwave, Pulsed Electric Field, Ohmic)	Heating food via radio waves (e.g., microwaves and pulsed energy) causing rapid molecular vibration of water or via electrical resistance (ohmic) to achieve pasteurization or sterilization	Meat, potatoes, grains, and vegetables	Yes	Food safety; shelf-life; causes less structural changes compared to other thermal processes	Potential loss of heat-sensitive vitamin(s); modifies food structure
Infrared Heating	Heating the surface of the food by absorption of infrared radio waves followed by heat conduction to achieve a desired internal temperature in the food	Meat, potatoes, grains, and vegetables	No	Food safety; used in food service to maintain the required temperature of cooked foods	Slow heating process makes it inefficient for high throughput production systems; leads to more moisture loss compared to other thermal processes and modifies texture
Canning & Pressure Cooking	Cooking food in a can or jar over 250 F for a set time period to potentially destroy microorganisms, including spores (e.g., *Clostridium botulinum)*, to	Meat, vegetables, potatoes, jams, jellies, and some dairy products	Yes	Food safety; shelf-life	Substantial loss of heat-sensitive vitamin(s). Container seal integrity is a critical factor in canning process to ensure correct treatment and that the package

	achieve food sterility				remains commercially sterile post processing
Extrusion Cooking	Blended food mixture is heated to a specific temperature and simultaneously driven by the extrusion screw towards the head of the press and forced through a die to potentially destroy microorganisms	Grain based pastas, ready-to-eat cereals, and proteins derived from plant sources	No	Food safety; makes the food convenient to use, for example pasta can be easily rehydrated and cooked	Potential loss of heat-sensitive vitamin(s); changes texture
Pressure Assisted Thermal Sterilization	Combining high pressure processing with heat to achieve sterilization temperature	RTE meals, vegetables, fruits, meats	No	Food safety; less nutrient, flavor, texture, and color loss than traditional pressure cooking	Limited scaling and availability; high cost associated with equipment and packaging