

SECTION 4

RECIPE ENGINEERING

Menu design with production constraints

1. The number of items on the menu must not be more than the kitchen can produce and achieve recipe item sensory standards.
2. The recipe items must meet customer sensory and value criteria.
3. The kitchen storage space and production equipment must be adequate.



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Recipe Engineering for Food Safety, Value, and Facility

Menu Design

The number of items on the menu must not be more than the kitchen personnel have the skill and time to produce with equipment that is capable of handling the volume. Quality is always governed by customer expectations. Once sensory standards are set to meet customer expectations, limits must be set for the menu item load. How many different items and how many servings can be prepared in a defined kitchen layout before the food quality begins to decline?

This point is often forgotten when menus are changed or promotional items are added. The kitchen or production plant establishes the limits of types and amounts of food that can be produced. Menu items must be added or subtracted with these limits in mind. High-volume, high-quality menu items should be chosen to maximize profits. If the quality level drops, the customer's confidence is lost, and possibly the customer will be lost also--to the competition.

Price-Value Relationship

A high-quality food product is of no value unless it meets the sensory and value criteria of customers. Customers appreciate quality and attempt to choose the best product for their money. The price-value relationship must be within customer expectations. For example, a lobster dinner for \$2.50 would be eyed just as suspiciously as a hamburger for \$15.00.

Storage and Equipment Requirements

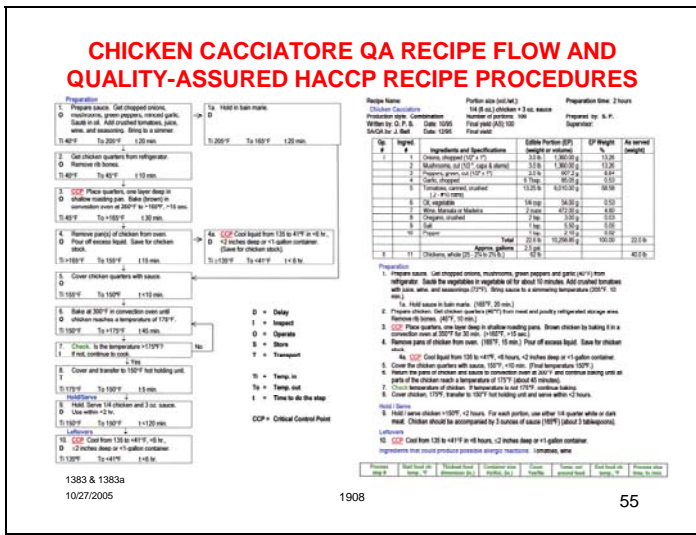
Anticipated customer demand for menu items must be considered when judging the amount of ingredient storage space needed. To assess the amount of storage space required, a well-written master recipe manual can be used to determine the amounts of ingredients necessary to meet customer count. From the amounts of ingredients in weights, the volumes can be figured and totaled to give storage space requirements.

The same type of computation can be done for equipment, using the amounts needed, equipment capacity, and batch times. This is the only way to assess whether a menu or promotion can be

prepared successfully or will strain the system to the point of failure. If the study indicates that the facility cannot handle the new product preparation, the necessary added capacities are determined and the kitchen capability is expanded.

References

- Bauman, H. E. 1974. The HACCP concept and microbiological hazard categories. *Food Technol.* 28(9):30-34.
- Snyder, O.P. 1981. A model food service quality assurance system. *Food Technol.* 35(2):70-76.



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Recipe Flow Chart and HACCP Recipe

Most retail foodservice operations do not have the luxury of a quality control laboratory to ensure the safety of food. The owner of a foodservice operation must rely on each food handler's ability to judge, visually and by time and temperature knowledge, whether foods are safe. Because there is no laboratory to measure the invisible microorganisms, toxins, and poisons, and because there are no telltale sensory signs, the only choice, when the safety of a food is in doubt, is to throw it out. The most critical reason to doubt the safety of food is probable time-temperature abuse, which means there has been an opportunity for more than 10 generations of *Listeria monocytogenes* multiplication. Throwing food out is costly. The way to avoid waste and to prepare safe, high quality food products is to teach each food preparation person to assure rapid rotation of refrigerated food and to consistently follow recipe procedures in which time, temperature, and other critical process parameters are carefully specified.

By analyzing food processes for potential hazards and rewriting policies, procedures, and standards to ensure safe handling and holding temperatures of foods, the food safety program manager/chef can virtually eliminate the risk of causing a foodborne illness outbreak as a result of consumption of any food product produced by the operation. This HACCP method of recipe process control not only contributes to making the final product safe, but also assures delivery of optimal quality products.

The HITM recipe analysis utilizes HACCP for seven recipe classifications, as discussed in Section 5. There are two basic microbiological hazards in food: infective microorganisms and spores. As a recipe is written or analyzed, times and temperatures used to prepare, serve or store the product must control growth of infective pathogens and outgrowth of pathogenic spores. Procedures are also specified for controlling chemicals and hard foreign objects in food.

Completing a Quality-assured HACCP Recipe Procedure (QARP). Choose a standard recipe used for quantity food preparation. To complete a quality-assured recipe procedure, carefully write the recipe name on the QARP recipe form. Identify the production class from the seven recipe classes.

Enter the recipe size (e.g., 30 portions). Put in your name and date of preparation of the QARP. List all ingredients necessary for preparation

Next, divide the recipe into its basic production stages from thawing and cleaning to leftover handling. The control of purchasing, receiving, and storage is handled by personnel assigned these responsibilities, so it need not be in the QARP. Cleaning and sanitizing to prevent cross-contamination from hands, cutting boards, knives, is also covered by procedures and standards and need not be repeated. For each step you must list the specific critical control points shown on the CCP (Critical Control Points) line. This includes:

Thickest food distance in inches. For a turkey breast, it could be 3 inches. For a steamship round of beef, it could be 12 inches. This is the reason large items such as steamship rounds cannot be cooked to uniform quality and safety standards. To prevent multiplication of *Clostridium perfringens*, the center of the food must be heated from 41 to above 130°F in less than 6 hours.

Container size in inches. The height, width, and length of containers must be specified so that cooks will be able to duplicate cooking times.

Covering or uncovering food. Covering affects cooking, because it prevents evaporative cooling. A covered container requires half the amount of energy to heat (or reach a pasteurization temperature), and the surface remains hot, enabling complete pasteurization of the contents. Covering also affects hot holding by preventing evaporation and cooling of the surface of products. Uncovered, hot food will have a surface temperature of below 120°F. (This temperature will allow some pathogens to multiply.) While uncovered food cools more rapidly, the surface becomes contaminated, especially with yeast and mold from the evaporator and other food in the refrigerator. As a result, it will spoil usually in less than 5 days.

Specified temperatures. These include temperatures for storage, preparation, cooking (range top, oven, fryer or griddle temperatures), and degree of doneness.

FOOD PASTEURIZATION TABLE

Temp (°F)	Ground Meat, and Fish		Roast Beef		Shell Eggs, Other Raw meat and Fish, (not ground)	All Poultry
	5 D Kill (100,000:1 Calculated)	FDA Code	6.5 D Kill (3,160,000:1 Calculated)	FDA Code		
130			112 min.	112 min.		
140	8.6 min.		11.2 min.	12 min.		
145		3 min		4 min	15 sec.	
150	51.6 sec.	1 min	67 sec.	67 sec		
155	16 sec.	15 sec.				
160	5.2 sec.	<1 sec.	6.7 sec.	0		
165						15 sec.

The air velocity of convection ovens and blast freezers or chillers should be mentioned. Equipment used to prepare the food should also be mentioned (e.g., cooking in boiling water on a gas range or in a pressure steamer). The goal is to heat food for specified periods of time (pasteurize) in order to reduce *Salmonella* spp. from 10,000,000 per gram of food to 1 per gram of food.

Starting food center temperature. This is the center temperature at the beginning of the heating-cooling cycle.

End food center temperature. This is the center temperature at the end of this process step. The goal is that prior to preparation, the raw food spend less than 7 days at below 41°F, 24 hours or less between 41 and 50°F in pre-preparation. In hot holding, to retain nutrients, the time should be under 30 minutes. At hotter than 130°F, covered food is safe. However, customers want soup, vegetables, and other hot entree items above 160°F and meat above 150°F. Therefore quality considerations usually dictate hot holding temperatures.

Process time. This is the shortest time it will take to complete the step in minutes and hours (for cooking), and longest time (for hot or cold holding, preparing, mixing, or cooling).

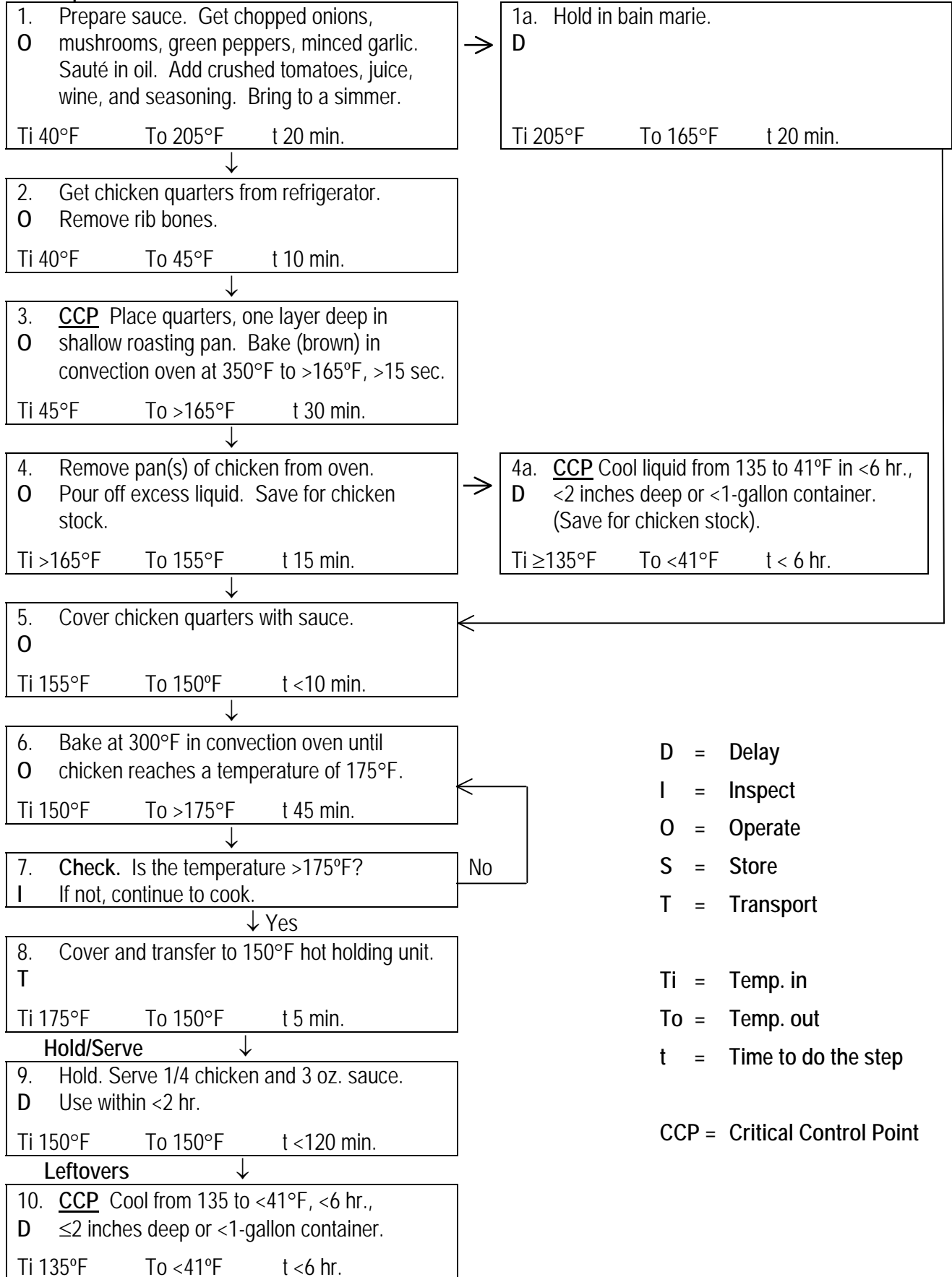
An example of a quality-assured recipe follows. Note that from a quality and nutritional viewpoint, leftovers should only be reheated once.

The recipe procedure also has a space for "served with" and "plating instructions". If food is reheated in a microwave oven, plating becomes a hazard control point to assure uniform reheating.

There is also space on the recipe form for identifying the ingredients that might cause allergic reactions. Some people are very sensitive to some ingredients, and these ingredients must be identified so that servers can be informed to warn customers, if necessary.

CHICKEN CACCIATORE QA RECIPE FLOW

Preparation



QUALITY-ASSURED HACCP RECIPE PROCEDURES

Recipe Name: **Chicken Cacciatore** Portion size (vol./wt.): **1/4 (6 oz.) chicken + 3 oz. sauce** Preparation time: **2 hours**
 Production style: **Combination** Number of portions: **100** Prepared by: **S. P.**
 Written by: **O. P. S.** Date: **10/95** Final yield (AS): **100** Supervisor:
 SA/QA by: **J. Bell** Date: **12/95** Final yield:

Gp. #	Ingred. #	Ingredients and Specifications	Edible Portion (EP) (weight or volume)		EP Weight %	As served (weight)
I	1	Onions, chopped (1/2" x 1")	3.0 lb	1,360.00 g	13.26	
	2	Mushrooms, cut (1/2", caps & stems)	3.0 lb	1,360.00 g	13.26	
	3	Peppers, green, cut (1/2" x 1")	2.0 lb	907.2 g	8.84	
	4	Garlic, chopped	6 Tbsp.	85.05 g	0.53	
	5	Tomatoes, canned, crushed (2 - #10 cans)	13.25 lb	6,010.00 g	58.58	
	6	Oil, vegetable	1/4 cup	54.00 g	0.53	
	7	Wine, Marsala or Madeira	2 cups	472.00 g	4.60	
	8	Oregano, crushed	2 tsp.	3.00 g	0.03	
	9	Salt	1 tsp.	5.50 g	0.05	
	10	Pepper	1 tsp.	2.10 g	0.02	
		Total	22.6 lb	10,258.85 g	100.00	22.0 lb
		Approx. gallons	2.5 gal.			
II	11	Chickens, whole (25 - 2¼ to 2½ lb.)	62 lb			40.0 lb

Preparation

1. Prepare sauce. Get chopped onions, mushrooms, green peppers and garlic (40°F) from refrigerator. Sauté the vegetables in vegetable oil for about 10 minutes. Add crushed tomatoes with juice, wine, and seasonings (72°F). Bring sauce to a simmering temperature (205°F, 10 min.).
 - 1a. Hold sauce in bain marie. (165°F, 20 min.)
2. Prepare chicken. Get chicken quarters (40°F) from meat and poultry refrigerated storage area. Remove rib bones. (45°F, 10 min.)
3. **CCP** Place quarters, one layer deep in shallow roasting pans. Brown chicken by baking it in a convection oven at 350°F for 30 min. (>165°F, >15 sec.)
4. Remove pans of chicken from oven. (165°F, 15 min.) Pour off excess liquid. Save for chicken stock.
 - 4a. **CCP** Cool liquid from 135 to <41°F, <6 hours, <2 inches deep or <1-gallon container.
5. Cover the chicken quarters with sauce, 155°F, <10 min. (Final temperature 150°F.)
6. Return the pans of chicken and sauce to convection oven at 300°F and continue baking until all parts of the chicken reach a temperature of 175°F (about 45 minutes).
7. **Check** temperature of chicken. If temperature is not 175°F, continue baking.
8. Cover chicken, 175°F, transfer to 150°F hot holding unit and serve within <2 hours.

Hold / Serve

9. Hold / serve chicken >150°F, <2 hours. For each portion, use either 1/4 quarter white or dark meat. Chicken should be accompanied by 3 ounces of sauce (165°F) (about 3 tablespoons).

Leftovers

10. **CCP** Cool from 135 to <41°F in <6 hours, ≤2 inches deep or <1-gallon container.

Ingredients that could produce possible allergic reactions: Tomatoes, wine

Process step #	Start food ctr. temp., °F	Thickest food dimension (in.)	Container size HxWxL (in.)	Cover Yes/No	Temp. on/ around food	End food ctr. temp., °F	Process step time, hr./min.
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MEAT PURCHASING HACCP

- Government inspected
- Government graded
- Purchaser inspected



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Meat Purchasing HACCP

Government Inspected

Meat must be inspected by federal inspectors if it is to be marketed in interstate commerce. Government inspection of meat is done to ensure that:

1. Meat is wholesome and fit for human consumption: this inspection controls the marketing of diseased or dead animals
2. Processing areas and equipment pieces are sanitary
3. Labeling accurately describes product in accordance with existing standards of identity and lists approved ingredients as required.

Unfortunately, government inspection has little correlation with microbiological quality. High-quality hamburger has as few as 100 spoilage microorganisms per gram. However, hamburger that has 10,000,000 spoilage organisms per gram will still pass government inspection. Raw meat, poultry, and fish are normally contaminated with 1 to 1,000 pathogens per gram. It is up to the chef/cook to assure the safety of the items through pasteurization (i.e., heating the meat to temperatures for a period of time necessary to decrease the microorganisms to a non-hazardous level).

Government Graded

Meat that has been USDA inspected may be graded for quality and yield. Grading of meat is not mandatory. There are 8 quality grades for beef animals: Prime, Choice, Good, Standard, Commercial, Utility, Cutter, and Canner. These grades are based on color and texture of the meat, character of the bones, and fat deposition. Generally, the 4 top grades (Prime - Standard) are younger animals, while the lower grades are older, more mature animals. Beef carcasses may also be yield graded and assigned a value of 1 to 5. A carcass that has a yield grade of 1 has a lower amount of fat and will yield a higher amount of lean meat. A yield grade of 5 indicates the carcass has a very high proportion of fat to lean meat and is the lowest yield grade.

Lamb carcasses are graded Prime, Choice, Good, Utility, and Cull. Pork carcasses carry no grade mark for quality.

USDA quality grades should be used to establish ingredient specifications by comparing costs and yields of carcasses from different suppliers.

Purchaser Inspected

The quality attributes identified in the grading information can be used to monitor the quality decline of meat products and estimate their degree of degradation.

Grades are assigned at the point of shipping and are no guarantee of quality at the time of delivery.

There are many possibilities for the mishandling of meat products during distribution that can result in product spoilage. Purchasers must know the quality attributes of fresh meat products and should not rely on grading as the only way to assure high quality products. Quality grades should be used as a reference and common ground when dealing with people who are not familiar with the high quality characteristics of fresh meat products.

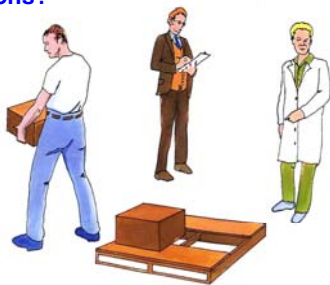
References

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INSPECT YOUR PURVEYORS

Can they obtain, store, and deliver products meeting the specifications?

Dirty floors
Broken and open cases
Spilled food
Dirty employee uniforms
Rust and lack of paint



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Inspecting Purveyors to Assure Quality

Inspecting Purveyors

One of the critical controls in a foodservice or food production operation is to check on the QA systems of suppliers (e.g., distributors, producers, processors). The production facilities and warehouses of purveyors should be inspected at least twice a year.

Inspection of purveyors should establish whether they can obtain, store, and deliver products that meet defined specifications. Inspections should focus on:

- Overall efficiency of the business
- Operational problems causing damaged or poor quality product (e.g., dirty floors and equipment; broken and open cases; spilled food; dirty employee uniforms and employees; rust, lack of paint and general maintenance)
- Lack of organization.

For a more detailed analysis of purveyors and food producers, the Food System Quality Assurance (QA) Certification Criteria form (found on the next page) can be used.

Purveyor's Responsibilities

Purveyors must be responsible for inspecting their sources of supplies, which include meat packers, fish suppliers, and other warehouse sources. It is important to know what purveyors demand of their suppliers and what QC and QA checks the purveyors conduct.

The billing-inventory system provided by purveyors should be fast and accurate in order to prevent product deficits. Inventory corrections should be made to detect packing, billing, or credit errors. Responsible purveyors have accurate, daily inventory systems and provide this information to their sales people so that orders will be filled.

References

Kotschevar, L.H. 1975. Quantity Food Purchasing, 2nd ed. John Wiley Sons. New York, NY.

RECEIVING, INSPECTING, AND STORING INGREDIENTS

Government-inspected food

Check delivery vehicle is sanitary
Refrigerated food $\leq 41^{\circ}\text{F}$
Frozen food is frozen; no ice crystals
Return non-specification items
Rotate stock, FIFO



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Quality Control in Receiving, Inspecting, and Storing Ingredients

Receiving Deliveries

When receiving a delivery, it should be checked against the order as the truck is unloaded. This procedure will allow the refusal of any non-ordered or unspecified product(s) before the invoice is signed. If any credits need to be written, arrangements should be made before the driver leaves. Weights and quantities of ordered items should be checked to determine whether pricing is correct. All items should be checked for physical damage from shipping or loading. Dented cans, broken dry ingredient containers, and produce of inferior quality should be rejected. Boxes and cartons of foods should be inspected for evidence of rats and cockroaches.

Receiving in this manner provides the opportunity to examine the truck while the driver is busy unloading. The truck should be clean and at proper temperature, if refrigerated.

Inspecting Raw Products

Perform spot temperature checks on meats and produce. All supplies must come from government-inspected suppliers. Alert the driver and company about any problems. Reject foods not within acceptable safety and quality tolerances. Check produce quality attributes to determine that fruits and vegetables are at their specified stage of ripeness. Wash delicate fruits and vegetables and store in covered containers to maintain a high humidity. Examine root and tuber vegetables for roots, tops, and sprouting.

The purveyor's invoice should be signed only after all products have been inspected for conformity to specifications, temperature, damage, and weight or quantity. Be ready to accept deliveries. Inadequate storage procedures lead to waste, quality deterioration, and possible safety hazards.

Storing Deliveries

All foods should be stored in areas appropriate for maximum quality retention. Products should be dated in order to ensure product rotation, and aid in loss prevention and future ordering.

Use FIFO (first in, first out). Always put the new items at the back, and the older items in front, to be used first. Never add fresh to old.)

Seals on packages of meat should be intact. Refrigerated, vacuum-packaged meat should be purple in color. It only turns red after exposure to oxygen. Fresh and cured meat should be stored as close to 28°F as possible for maximum quality shelf life.

The temperature of incoming refrigerated food should be below 41°F . Refrigerated food products must be stored in refrigerators or coolers before the outside layers reach 45°F .

Frozen food should be frozen when received and should show no signs of temperature fluctuation (e.g., formation of large ice crystals as a result of thawing and refreezing). Freezer storage temperatures for frozen products must be maintained below 0°F . Frozen products must be packaged in containers or packaging materials that prevent moisture loss and oxidative changes during storage.

Summary

- Products should be inspected as they are received to ensure that their quality lies within acceptable tolerances. If not, they should be rejected and returned.
- The majority of products should conform to specification. The amount of defective goods or those below specification should not exceed 5%.
- Products should be stored appropriately (in coolers, refrigerators, freezers, or dry storage areas) immediately after delivery to maintain quality and prevent microbial growth and contamination.

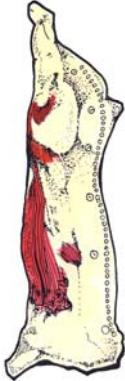
References

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MEATS

Quality attributes
 Texture even
 Fat distribution even
 Color: meat deep red or pale (non-beef); fat white
 Tenderness dependent on age: younger animals preferred
 Flavor and texture dependent on marbling
 Mild odor, if any

Quality retention
 Refrigerate at 30°F
 Frozen storage at ≤0°F, not fluctuating
 First in, first out (FIFO)



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Meat Quality Attributes

Texture. The even texture of meat is obtained through control of heredity (breeding), size, and age of the animal, individual muscular activity, and intramuscular fat content (marbling).

Color is dependent on the oxidation-reduction potential of the environment (packaging), maturity, and chemical state of hemoglobin and myoglobin (pigments responsible for meat color) in meat. The color of vacuum-packaged fresh meat is dark purple. This color indicates that no oxygen is present within the package. Vacuum packaging of meat assures a maximum shelf life of 15 to 25 days, depending on the microbiological quality of the meat, which is a direct reflection of sanitation during slaughter and packaging.

Note: If a vacuum package has been punctured and a bright cherry red color is evident, the product should be used as soon as possible, or wrapped tightly in freezer wrapping material and frozen for future use.

Tenderness and texture depend on several factors, which include:

1. Size of meat fibers: Older animals tend to have large muscle fibers; hence, the meat is coarser in texture.
2. Activity of the muscle: Cuts of meat taken from areas of a carcass that receive much exercise (e.g., chuck roast taken from the shoulder area) contain more connective tissue and are less tender than cuts such as tenderloins obtained from the interior portions of a carcasses and have received little or no exercise.
3. Amount, kind and distribution of connective tissue.
4. Degree of natural aging: This is the holding of meat after slaughter and passage of rigor mortis. It also influences tenderness. Some connective tissue will break down chemically when meat is "aged" naturally. As a result the meat becomes more tender.
5. Mechanical means (pounding, cubing, and grinding); marinades (soaking meats in wine, soy sauce, or vinegar); and enzyme treatments (use of meat tenderizers which can either be injected into carcasses or applied to the surface of cuts): These procedures can make cuts of meat more tender.

Flavor of meat is dependent on:

1. Age of the animal: Meat obtained from older animals tends to have more flavor. Often this is affected by the amount of fat deposition within the muscled areas. For example, veal and lamb are marketed at a very early age and are milder in flavor than meat taken from 2-year old beef animals or sheep.
2. "Aging" (holding of meat after slaughter): Compounds that influence the flavor and odor of the meat are also formed during aging. Beef and lamb carcasses are often aged (even for short periods of time, under controlled conditions). Veal and pork carcasses are never aged.
3. Growth of spoilage microorganisms: These microorganisms alter the color, flavor, and odor of meat.

Meat Storage

Meat and meat products must be stored at 28 to 30°F to ensure maximum shelf life and optimum flavor. Frozen meats should be stored at 0°F or less for short periods of time and at -10°F or less for long periods of time. Colder temperatures will slow the oxidation of fat, which causes rancidity, and development of off-flavors in meat.

Temperature fluctuations during freezer storage causes ice crystal development and subsequent excess drip losses from meat when it is thawed. Frozen meat products should be packaged in material that conforms to the product and does not allow the evaporation of moisture and entrance of air.

Meat products stored improperly are more likely to have rapid development of off-flavors and will have a shorter shelf life.

References

- Charley, H. 1982. Food Science. John Wiley and Sons. New York, NY.
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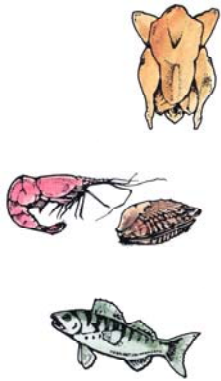
POULTRY, FISH, AND SEAFOOD

Quality attributes

- Full-fleshed, meaty, firm
- Appropriate color, including fat on poultry
- Not bruised
- No rancid or off-odors
- Crustacea alive;
- mollusks tightly closed, if fresh
- Shellfish tagged

Quality retention

- Avoid prolonged storage
- Frozen storage at -10 to 0°F
- Avoid cross-contamination and contact with reactive container
- Separate fish from their drip



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Poultry, Fish, and Seafood - Quality Attributes and Quality Control Storage

Poultry Quality Attributes

The quality of poultry is determined by the muscle development or fleshing. A thin, even coating of fat on the entire exterior provides flavor and basting, rather than fat within the muscle. Big chunks of fat are a waste and should be removed.

Poultry Quality Retention

Chicken and other types of poultry have higher pathogenic and spoilage bacterial counts than almost any other food. Poultry should be ordered in quantities that will be used within a short period of time, so that there is rapid turnover and no prolonged storage. Fresh poultry should be refrigerated at 28 to 30°F and packed in ice.

When poultry is frozen, it should be packaged in tight-fitting, impermeable bags to prevent dehydration and rancidity. Freezer storage temperatures should remain at less than 0°F.

Quality Attributes of Fish and Seafood

The appearance and odor of fish are clues to its freshness. The skin of a fresh fish is shining and iridescent. The eyes are full and bright. The gills are bright pink. The flesh of fish, once rigor has passed, is soft and flabby and does not pit when pressed with a finger as does fish that is no longer fresh. The flesh is translucent and shimmering when cut, rather than dull and milky in appearance. The aroma of fresh fish is not unpleasant and is often described as "seaweed," in contrast to the "dead fish" odor of fish too long out of water. Fresh seafood has a maximum quality shelf life of about 2 to 3 days, depending on its microbiological load and temperature controls used after catch.

Some crustacea such as lobsters and some shellfish are purchased in the live state for maximum freshness and quality. Most shrimp usually have better quality if they are glaze frozen and then thawed properly and handled at the retail level. Fresh shrimp has a shelf life of only 24 hours or less.

Fish Quality Retention

Spoilage occurs rapidly in fish, even at refrigeration temperatures. Fish is contaminated with microorganisms that

grow at refrigeration temperatures, causing the development of off-flavors and odors and textural changes in the flesh of fish. Fresh fish should be stored refrigerated no longer than 2 to 3 days. If it is to be stored longer, it should be frozen.

When fish is frozen, the fat (lipid portion) is susceptible to oxidative changes, which cause rancidity to develop, as evidenced by the development of off-flavors. Undesirable textural changes also take place in frozen fish. Often times, frozen fish loses water and becomes quite dry and stringy when it is cooked.

Frozen seafood should be stored below -10°F. Many frozen fish suppliers "glaze" (i.e., dip in water and then refreeze to provide a protective coating of ice on the surface) frozen fish to extend the shelf life of these products.

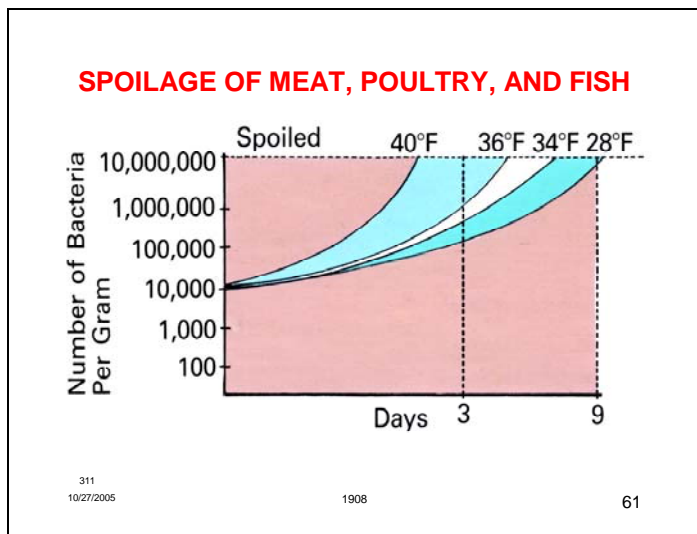
Summary

Time and temperature are the most important factors in maintaining the quality of seafood.

- Fresh fish should be chilled or frozen immediately after it is gutted. Commercial methods super-chill fish and seafood products rapidly by bringing the surface temperature just below 0°F. The seafood is then vacuum packaged and frozen rapidly in blast freezer units.
- Fresh fish should be consumed within 2 to 3 days.
- Thawed frozen seafood should be consumed within 24 hours.

References

- Charley, H. 1982. Food Science. John Wiley and Sons. New York, NY.
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Spoilage of Meat, Poultry, and Fish

Rate of Deterioration

The rate of deterioration of meat, poultry, and fish is directly related to the temperature, bacterial load and type, and pH. These products provide good media for spoilage and pathogenic bacterial growth. As can be seen from the illustration above, these products will spoil more rapidly due to the bacterial growth if they are stored at 40°F in contrast to storage at 28°F (2 1/2 days storage, in contrast to 9 days). The length of time these products can be stored under refrigeration is related to the effectiveness of temperature control and the numbers and types of bacteria present on these products.

If the pH of meat, poultry, and fish is 6 to 7, microbial growth will be more rapid than when the pH is lower, approximately around 5.6.

Importance of Sanitary Slaughtering Operations

Sanitation during slaughtering and gutting operations determines the quantities of bacteria in the end products. Processors must aim to keep the microbial counts on meat, poultry, and seafood as low as possible. Longer product shelf life is determined not only by storage temperatures of 28 to 30°F, but also adequate sanitation of the slaughtering and dressing operations.

References

Ingram, M., and Simonsen, B. 1980. Meat and meat products. In *Microbial Ecology of Foods, Vol. II. Food Commodities*. Academic Press. New York, NY.

DAIRY PRODUCTS (MILK, CHEESE, YOGURT, FROZEN DESSERTS, ETC.)

Quality attributes

- No undesirable flavors or odors
- Appropriate color
- No undesirable fermentations
- No crystallization in frozen products

Quality retention

- Refrigerated at 41°F; butter at 28°F
- Rotate rapidly
- Freeze at <0°F without fluctuations
- Do not refreeze once tempered
- Do not store with strong-aroma foods



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Dairy Products - Quality Attributes and Quality Control Storage

Quality Attributes

The safety of milk for human consumption is achieved when milk is pasteurized. This heat treatment effectively destroys microorganisms that might cause illness. A high-temperature short-time process (161°F for 15 seconds) is commonly used today. Raw unpasteurized milk is a source of pathogenic microorganisms that can cause severe illnesses. No raw milk or raw milk products should be served or used in any foodservice facility. Some spoilage bacteria survive pasteurization. The expiration date on milk cartons and other dairy products is an estimate of the time needed for the growth of acid-producing bacteria and other microorganisms to multiply enough to affect the flavor adversely.

High quality dairy products have no undesirable flavors or odor. They possess no off-colors and have a color that is appropriate for the product. No undesirable fermentations have taken place (e.g., milk sours and curdles due to the growth of lactic acid bacteria). Frozen products are smooth and have a light creamy texture; no large ice crystals are present.

Quality Retention

If stored properly, dairy products will retain high quality characteristics for a longer period of time. Storage temperatures of less than 41°F (approximately 35°F) are best to slow the growth of spoilage microorganisms, which include lactic acid bacteria, yeasts, and molds. Milk should be kept away from light in order to prevent the loss of riboflavin and oxidation of the fat components.

The fat in butter will undergo oxidation when butter is stored for long periods of time and a rancid flavor will develop. Butter should be kept as cold as possible (28 to 30°F) but should not be frozen. The lipid (fat) components of butter, cream, and cheese will absorb flavors and aromas of other foods. These products should be stored in containers or sealed in packaging materials that prevent this from occurring.

Fermented milk products (e.g., sour cream, buttermilk, yogurt, all cheese) are produced by culturing these products with appropriate bacterial cultures. These bacterial cultures are not

only useful in producing different types of dairy products but are beneficial in minimizing the growth of pathogenic bacteria. The pH of the dairy food (e.g., sour cream, cheese, yogurt) is decreased to a level that is unfavorable for the growth of pathogenic bacterial.

Spoilage does occur in these products as a result of mold growth. Propionates and sorbates are commonly added to prevent mold growth and increase the refrigerated shelf life of these products.


To retain optimum quality in ice cream and other frozen dairy products, they must be stored at -10 to 0°F until needed for use. If frozen dairy products are stored at higher temperatures or if the freezer storage temperature fluctuates to a great extent, large ice crystals will form and products will become grainy with a "gummy" texture. Hard ice cream should be allowed to temper at 10 to 15°F for 24 hours prior to dipping and rolling.

References

- Charley, H. 1982. Food Science. John Wiley and Sons. New York, NY.
- Olson, J.C., and Mocquot, G. 1980. Milk and milk products. In Microbial Ecology of Foods, Vol. II. Food Commodities. Academic Press. New York, NY.
- Terrell, M.E. 1979. Professional Food Preparation. 2nd ed. John Wiley & Sons. New York, NY.
- USDA. Standards for grades of cheeses. Consumer and Marketing Service, Dairy Div. Washington, D.C.

EGGS

Quality attributes
 Thick white height
 Yolk height
 Shell shape
 Weight
 Cleanliness of shell
 Grades: USDA AA, A, B, C



Quality retention
 Store at 41°F, 70% relative humidity
 Avoid prolonged storage
 Keep away from other strong odors

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Eggs - Quality Attributes and Quality Control Storage

Quality Attributes

The interior quality of fresh, in-shell eggs is determined by candling (i.e., holding the egg in front of a beam of light). Candling can determine the size of the air cell and if the yolk is centered. The yolk membranes extend from both ends of the yolk and are attached to the ends of the shell. This rope-like membrane (chalazae) stretches as the egg ages, thus allowing the yolk to move off center or even affix itself to the inside of the shell. The size of the air space at the top of the egg is also an indicator of age. The older the egg, the more moisture is lost and the greater the air space. The amount of thick white around the yolk decreases with egg age. Yolk centering, air space, and white height have no effect on the baking performance of an egg, but do influence the appearance of fried, poached, and shirred eggs. Exterior quality attributes include a well-formed shape and a sound, clean shell.

Eggs are graded according to size and quality. Eggs vary in size and are classed as one of 6 sizes: jumbo, extra large, large, medium, small, and peewee. The smallest eggs, peewee, are half as large as jumbo eggs. When a recipe calls for eggs, it is appropriate to weigh or measure the volume of eggs used in the product.

Quality grades of eggs are AA, A, B, and C. Eggs of grade AA or A quality have a small air space, a large amount of thick white, and a well-centered yolk. Although eggs may be graded and labeled as grade AA or A quality, the USDA allows 20% of the number in a carton or case to be of lower quality. The USDA also allows eggs to reach a temperature of 60°F (15.6°C) during storage and distribution. At this temperature, egg quality declines rapidly.

Since 1987, it has become evident that the yolk of intact Grade A shell eggs produced by diseased flocks of hens can carry *Salmonella enteritidis*. These diseased eggs have been responsible for outbreaks of *Salmonella* in Europe and the United States. As a result of these outbreaks, the FDA in August of 1990 classified intact shell eggs as potentially hazardous.

In order to prevent an outbreak of *Salmonella enteritidis*, foodservice establishments should:

1. Buy eggs from producers who certify that the flocks of hens producing the eggs are *Salmonella*-free.
2. Use only pasteurized, liquid egg products whenever possible in the preparation of food items requiring eggs.
3. Cook uncertified shell eggs to 145°F or above for 15 seconds in order to inactivate any *Salmonella* that might be present in the egg.
4. Never use raw eggs as an ingredient in the preparation of uncooked, ready-to-eat menu items.
5. Buy eggs that have been maintained in refrigerated storage at less than 41°F since shortly after being laid.

Quality Retention

To prevent dehydration and retain quality, refrigerate eggs at 41°F and 70% relative humidity. In order to retain the microbiological quality of eggs as well as maximum quality for use as a food product, eggs must not be allowed to remain at temperatures above 41°F. Eggs should not be stored near foods with strong odors because eggs absorb off-flavors and odors.

References

- Board, R.G. 1983. A Modern Introduction to Food Microbiology. Blackwell-Mosby Book Distributors. St. Louis, MO.
- USDA. Egg Grading Manual. Agric. Handbook No. 75. USDA Food Safety and Quality Service. Washington, D.C.

LEAFY SALAD VEGETABLES AND FLOWER VEGETABLES

Quality attributes

Compact heads
Free from injury, bruising,
insect damage
Minimal wilt

Quality retention

High spoilage risks
Refrigerate at 32°F,
95 to 100% relative humidity



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Leafy and Flower Vegetables - Quality Attributes and Quality Control Storage

Quality Attributes

Quality of leafy vegetables (e.g., lettuce, cabbage, romaine, spinach, etc.) is determined by the presence of crisp leaves with no evidence of wilt, rot, or freeze damage. Hard, pale and oversized heads of lettuce and cabbage should be avoided because they are overgrown and taste bitter. A common quality problem found in lettuce is the development of russet spotting. This condition is indicated by the presence of rusty-brown spots on the lower ribs of outer leaves and is caused by the presence of ethylene gas, a by-product of fruit and vegetable decomposition.

Darkness of the cut stems of lettuce or cabbage is also an indicator of age. The stem darkens in direct proportion to temperature and time. Lettuce that is field-chilled has the highest quality and does not brown as rapidly when cut. Heads of lettuce and cabbage should be compact and well trimmed to ensure good cutting yield.

Good quality flower vegetables (e.g., celery, asparagus, broccoli, cauliflower etc.) should be fresh, not limp, with compact, well-colored crisp stalks and tender tips. (These vegetables should be trimmed and tough woody stems should have been removed.) The sweetness and tenderness of asparagus can be lost easily if the product becomes warm, ages, the tip opens, or the stalk wilts and becomes stringy.

Vegetables may easily carry insects, herbicide residue, and microorganisms. Care must be taken to purchase and store them carefully and to wash the vegetables thoroughly before they are cooked or eaten raw.

Quality Retention

To retain highest quality for the longest period of time, these vegetables should be stored at 32°F and in a humid environment (95 to 100% relative humidity).

References

Ryder, E.J. 1979. Leafy Salad Vegetables. Avi Publishing Co. Westport, CT.

TUBERS, ROOT VEGETABLES, AND SQUASH

Quality attributes

Firm, well shaped
Appropriate color, size, trim
Free from sprouts, sunburn,
harvest damage

Quality retention

Store roots at 32°F,
95% relative humidity;
tubers at 40 to 50°F,
70% relative humidity,
in dark to prevent sprouting



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Tubers, Vine and Root Vegetables - Quality Attributes and Quality Control Storage

Quality Attributes

Tubers, squash, and root vegetables can be stored successfully for much longer than other vegetables. Root vegetables should be clean and have a short length of top retained. The microbial hazards of these vegetables are the spores of *Clostridium botulinum*, *Clostridium perfringens*, and *Bacillus cereus*, which may not be washed off and may grow out to form vegetative cells / toxins in the cooked products where spoilage organisms no longer exist to inhibit their growth.

Potato quality attributes are firmness, smooth skin for easy cleaning, good shape for easy peeling, and no major defects. Some major defects are greening (due to sunlight), harvesting scars, bruises, and hollow heart (a brown, open area in the center of the tuber). Green areas must be removed because they can be due to the formation of a toxic compound known as solanine. Some varieties of potatoes darken after cooking. This seems to be related to the acid and iron content of the soil in which they were grown.

Potatoes are sized by counts per bushel or by weight. When buying potatoes, variety, grade, and size should be specified. Specific gravity determines whether the potato will be mealy or waxy when cooked. A specific gravity of at least 1.08 is desirable for baking or mashing; 1.07-1.08 for boiling; and below 1.07 for frying.

Quality attributes of onions and garlic are hardness, dry skin with small necks, and no softness or wetness. There should be no evidence of green sunburn or sprouting. Strong onions store for a longer period of time than do mild onions due to their higher content of pyruvic acid. Firm, smooth, and well-shaped onions and garlic are essential to ease of preparation and minimal waste.

Quality Retention

Potatoes should be stored at 40 to 50°F, 70% humidity. Colder temperatures cause potatoes to produce sugar from starch reserves. Potatoes stored at refrigeration temperatures brown excessively when cooked, particularly when fried.

For best quality retention onions and garlic should be refrigerated at 32°F and stored in a relatively high humidity of 95%.

References

- Goepfert, J. M. 1980. Vegetables, fruits, nuts, and other products. In *Microbial Ecology of Foods, Vol. II. Food Commodities*. Academic Press. New York, NY.
- Pedderson, R. B. 1977. *Specs: The Comprehensive Food Service and Specification Manual*. Cahner's Books International, Inc. Boston, MA.

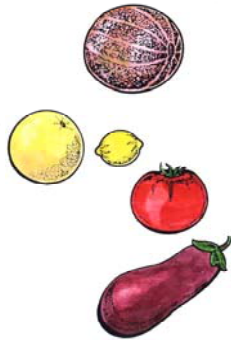
FRUITS AND SOFT-SKINNED VEGETABLES

Quality attributes

- Evenly shaped
- Uniform color
- Free of bruises, rot, mold, cracks

Quality retention

- Store ripe fruits at 40 to 50°F, 85 to 90% relative humidity
- Store mature green tomatoes at 55 to 70°F to assist ripening



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Fruits and Soft-Skinned Vegetables - Quality Attributes and Quality Control Storage

Quality Attributes

Select fruits and vegetables on the basis of measurable and easily identifiable quality attributes. These quality characteristics should be listed on purchasing orders so that consistent products are purchased and uniform standards are used to accept or reject items as they are delivered by suppliers.

Fruit Quality and Storage

For highest quality retention, inspect all fruit. Use damaged fruit immediately and discard soft, watery, or moldy fruit. Place fruit into clear polycarbonate tubs to make daily inventory more efficient, reduce storage space requirements, and facilitate early detection of mold growth. If mold is allowed to grow and produce spores that become air-borne, the mold may cause fairly extensive product loss. Refrigerate below 41°F, at 80 to 85% relative humidity. Do not mix storage of fruits with vegetables.

Note: The count on the citrus fruit case actually refers to the diameter of the fruit and not the number in the box. For example: Grapefruit 56 count means: Minimum Diameter = 4 2/16", Maximum Diameter = 4 12/16". Some Florida fruit is larger than Texas or California fruit of the same count due to a separate USDA quality grade status.

Apples are packed by count or minimum diameter. In general, apple quality is measured by degree of firmness, weight, and amount of sugar in the juice. For quality attribute retention, apples should be stored near 32°F. Apples soften nearly 5 times as quickly at 41°F as at 32°F.

Pears are best when picked green and are allowed to ripen off the tree. The starch stored in the flesh forms sugars during ripening, thus increasing the sweetness of the fruit.

Ripeness is often determined by feel and aroma that is characteristic for the fruit. Ripe peaches and nectarines yield to thumb pressure. Peaches are best if tree ripened, because they contain no starch reserves that convert to sugar after they are picked.

Berries (e.g., strawberries, raspberries blueberries) should be uniform in size and color, clean, dry, and free from leaves and stems. Ripeness is indicated strictly by color.

Overripe fruit is soft, dull in appearance, and watery. To retain quality of fully ripe fruit, it should be stored at 32°F and 90% relative humidity.

Melons (e.g., watermelons, cantaloupes, honeydews) are like peaches and have no starch reserves to turn to sugar upon ripening. Melons should be allowed to ripen on the vine. Melons should be sweet and have texture characteristic of the fruit. (Melon thumping has no merit.) For best quality retention of fully ripened melons, they should be stored at 45 to 50°F and 85 to 95% relative humidity.

The skin color of bananas is an excellent indication of the stage of ripeness. There are 7 established stages of ripeness related to the stages from solid green to speckled, fully ripe restaurant bananas. Green bananas can be ripened by allowing them to remain at 58°F until the desired state of ripeness is reached. Fully ripe bananas should be stored at 41°F in 85 to 95% relative humidity and used within a few days.

Tomato quality attributes are color, firmness, general interior appearance in terms of percent seeds, percent flesh and wall, and flavor. Color and size can be used to determine maturity. Tomatoes picked prior to ripening ship well and reduce the risk of loss to the grower and shipper, but do not taste vine-ripened. In order to get the freshest tomato flavor and the optimum in quality, vine-ripened tomatoes must be specified on orders. Tomatoes may be ripened at 55 to 70°F and refrigerated at 41°F to maintain quality.

Avocados may be picked when under-ripe and allowed to ripen at room temperature. Avocados are fully ripe when they yield to slight thumb pressure. Fully ripened avocados should be stored at 41°F and 85 to 95% relative humidity to maintain high quality for as long as possible.

Vegetable Quality and Storage

Fresh green beans should be well shaped and colored, clean, and free from marks or disease. The beans, when broken should snap with a crack. They should not be wilted or limp, which is a sign of moisture loss. To retain highest quality in fresh green beans, they should be washed prior to storage.

The best-tasting peppers are those with thick walls and a uniform-glossy color. Small brown specks on the exterior of pepper are a sign of hail damage and are considered a defect.

Color, size, and shape are used as quality indicators for many vegetables, including cucumbers and eggplant. For best quality, store these fresh vegetables at 45 to 50°F.

References

- Frazier, W.D., and Westhoff, D.C. 1978. Food Microbiology. 3rd ed. McGraw-Hill, Inc. New York, NY.
- Kotschevar, L.H. 1975. Quantity Food Purchasing. 2nd ed. John Wiley & Sons. New York, NY.
- Pedderson, R.B. 1977. Specs: The Comprehensive Food Service and Specification Manual. Cahner's Books International, Inc. Boston, MA.

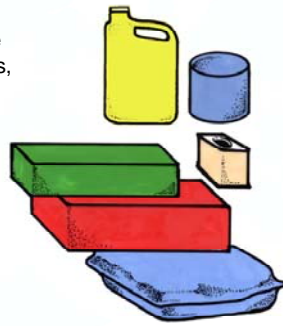
GROCERY DRY STORAGE ITEMS SALAD OIL, CANNED FOODS, HERBS, SPICES

Quality attributes

Quality decrease with storage
Package has no holes, breaks,
cracks, rust, dents
Natural aroma
No oxidation

Quality retention

Store at 60 to 70°F,
65 to 70% relative humidity
First in, first out
Avoid infestation
Herbs and spices must be
replaced at least every 6 months



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quantities to be used within 3 months. Spices should be stored in tightly covered, dark glass containers, in a cool and dry place such as the refrigerator or freezing unit.

Oil becomes very rancid, especially olive oil, after opening when exposed to the atmosphere. Opened containers of oil retain freshness longer when stored at refrigeration temperatures.

The flavor of coffee deteriorates rapidly after grinding due to loss of volatile flavor components. Coffee and tea should be bought in quantities that will be used in a short period of time (within 1 week) and stored in a cool, dry place, in tightly covered containers to retard flavor loss.

References

- Frazier, W.C., and Westhoff, D.C. 1978. Food Microbiology. 3rd ed. McGraw-Hill, Inc. New York, NY.
Kotschevar, L.H. 1975. Quantity Food Purchasing. 2nd ed. John Wiley & Sons. New York, NY.

Grocery / Dry Storage Items - Salad Oil, Canned Foods, Herbs, Spices

Dry Food Quality

Dried products have had enough water removed to prevent bacterial growth. Care must be taken to ensure that dried products stay dry. Original containers must be checked to make sure that the moisture seal has not been broken. The freshness of dried products may be checked by evaluating their aroma. Fats in dried foods will slowly become oxidized, producing off-odors. Leavening agents in cake, biscuit, and muffin mixes can react in the package, thus reducing leavening power and final quality of baked products. Pigments in dried vegetables and spices undergo oxidation resulting in color loss in these products. Volatile flavor compounds are also lost with prolonged storage. High temperatures and moisture will speed the deterioration of most dried foods. When packages are opened or damaged, the product should be used quickly to prevent rapid deterioration due to exposure to atmosphere.

Rice, beans, flour, and sugar are subject to pest infestation, to absorbing moisture, and to becoming contaminated by soil if the package is damaged. These foods should be stored in approved food storage containers that prevent absorption of moisture and entrance of vermin and insects.

Canned Food Quality

Canned products are fairly shelf stable because the canning process eliminates air and inactivates most microorganisms and spores. Canned goods are best if stored at temperatures no higher than 60 to 70°F.

Quality Retention

For the best quality retention of dry storage items, they should be stored at 60 to 70°F at a low (65 to 70%) relative humidity. All opened, dried products should be placed in labeled containers with tight fitting lids. Items should be rotated and used as quickly as possible. Insect and rodent infestation can be controlled by keeping dried food in tightly covered metal, glass, or plastic containers.

The flavor and odor of dried herbs and spices can change drastically within 6 months, causing variation in recipes and product quality. Spices must be purchased in small enough

