Table 9 .... Organoleptic Criteria of Quality in Fish

Factor	Good quality	Poor quality
Eyes	Bright, transparent, often protruding	Cloudy, often pink, sunken
Odor	Sweet, fishy, similar to sea weed	Stale, sour, presence of sulfides, amines
Color	Bright, characteristic of species, sometimes pearl essence at correct light angles	Faded, dull
Texture	Firm, may be in rigor, elastic to finger pressure	Soft, flabby, little resilience, presence of fluid
Belly	Walls intact, vent pink, normal shape	Often ruptured, bloated, vent brown, protruding
Organs (including gills)	Intact, bright, easily recognizable	Soft to liquid, grey homogeneous mass
Muscle tissue	White or characteristic of species and type	White flesh pink to grey, spreading of blood color around backbone

not fit for human consumption. There are not as yet any practical chemical or other objective methods of determining fish quality. Therefore, organoleptic methods are the only yardstick available for evaluating quality. Organoleptic indices of quality vary somewhat between various species of fish. In general, the information in Table 9 can be used in ascertaining fish quality.

In New England and the Canadian Maritime provinces groundfish unloaded from the vessel are usually forked into wooden boxes and then trucked a short distance to the shore plant, or conveyed directly from the hold or deck to the shore plant. The latter arrangement is preferred; but it is not always practical, especially at public piers where each vessel is not always allocated an equivalent location at the dock. Transportation of fish in dirty wooden boxes or carts can seriously effect the quality of the product. All boxes used should be cleaned regularly each day with steam, chlorinated water or other suitable cleansing agents. They should also be painted with a hard drying, nontoxic, impervious paint at least once every six months. Ice should be applied generously to each box of fish, even if time prior to processing is only a few hours. Fish in boxes in the plant awaiting processing for longer than those few hours should be iced heavily and stored in a refrigerated (35 F) chill room. If refrigerated facilities are not available, the boxes of fish should be kept in a cool section of the plant, free from vermin and insects, where adequate drainage is provided.

Larger fish such as salmon and halibut are frequently stored in bins or on the floor and then covered with a layer of ice 12 to 18 in. thick. Fish stored in ice should not be kept at the shore plant longer than overnight prior to processing. As an alternative, salmon have been stored in tanks containing refrigerated sea water chilled to 30 F at the shore plant while awaiting processing or canning. Industry reports indicate that this method has been successful.

Fresh fish are marketed in many different forms: as fillets, whole fish, dressed-head on, or dressed-headed (head removed), or in some instances as steaks. The method of preparing fish for marketing depends largely on the species of fish and on consumer preference. For example, groundfish such as cod and haddock are marketed usually as fillets, or as dressed-headed fish. Fresh-water fish, such as catfish and bullheads, are usually dressed and skinned; lake trout are not skinned, but are merely dressed and gilled, while lake herring are merely scaled and washed and marketed in-the-round. Fish from the Pacific coast such as salmon, tuna, halibut, and sablefish are usually marketed in the canned or frozen state.

Fresh fish fillets are usually packed in 25 lb metal containers for shipment to the buyer. These containers are put into 100 lb capacity wooden boxes and surrounded with a heavy layer of ice for shipment. Round and dressed fish are generally shipped in 100 lb capacity wooden boxes. The bottom of the box is covered with a layer of ice. The fish are then laid in the container and covered with an additional layer of ice. A ratio of about one pound of ice to two or three pounds of fish should be used. In shipping fresh fish, a refrigerated carrier, either railcar or truck, cooled to 35 F or 40 F should be used.

In stacking boxes of fish, adequate provision for drainage of run-off water from the ice should be made. This run-off water contains fish slime which is high in bacteria count.

FRESH FISH STORAGE

Total storage life of fish varies from species to species. In general, the storage life of East and West coast fish properly iced down and stored in refrigerated rooms (35 F) is about 10 to 15 days, with 15 days as the maximum. This is dependent upon the condition of the fish when unloaded from the boat. Fresh water fish properly iced down in boxes and stored in refrigerated rooms may only be held for seven days. Both figures are from the time the fish is landed and processed to the time of consumption by the ultimate consumer.

The storage temperature should not be below 35 F, for the ice on the fish must melt. Ice on the fish serves a two-fold function. The fish must not only be cooled and kept cold, but the surface of the fish must be constantly washed by the water from the melting ice to prevent the concentration of bacteria in the slime from becoming too high. If the ice on the fish is prevented from melting by holding in a storage room at or near the freezing point of water, the bacteria count in the slime will build up to a high level, and the fish will spoil or sour.

Fresh fish should be stored in a room of low air velocity in order to hold high room humidity to prevent pulling the ice off the fish by sublimation with consequent dehydration of the product.

When fresh fish is stored in refrigerated rooms by stacking of boxes, the run-off water from the melting ice should drain at the sides of the boxes near the bottom to prevent the solution of slime and ice water from draining through the layers of fish in the bottom of the pile. Adequate floor drainage must be provided to carry away such run-off water.

For further information on storage of fish at sea see Chapter 57 and also Bibliography in Chapter 40.

REFERENCES

[1] W. J. Scott: The growth of micro-organisms on ox muscle (*Journal of the Council of Scientific and Industrial Research*, Vol. 9, 1936 and Vol. 10, 1937).

[2] ASHRAE GUIDE AND DATA BOOK 1961 Chapter 27.

CHAPTER 32

POULTRY AND DAIRY PRODUCTS

POULTRY PRODUCTS: Processing, Refrigeration in Use, Design, and Distribution; MILK PROCESSING: Handling, Holding, Standardizing, Pasteurizing, Homogenizing, Storing, Distribution; BUTTER MANUFACTURE: Cooling Cream, Churning, Continuous Processes, Storing, Microbiology, Deterioration in Storage, Refrigeration Load; CHEESE MANUFACTURE: Processes for Various Types, Refrigeration Load

THIS chapter will discuss the use of refrigeration in the processing of: (1) poultry products, (2) milk, (3) butter, and (4) cheese.

PART I: POULTRY PRODUCTS

Refrigeration is an indispensable part of the nation-wide processing and distribution of poultry. In the form of flake ice or ice slush it is used to remove animal heat in the processing plant, and it makes possible the thousands of miles that poultry is transported from producing areas to markets. Finally refrigeration is an essential part of handling in the retail store and the home.

Over 80 percent of the five billion lb of broilers produced annually, and substantial proportions of other types of poultry, are marketed as a refrigerated unfrozen product. The remainder is marketed mainly as a frozen product. Refrigeration of poultry as discussed in this chapter will refer to chilling and maintaining temperatures down to but not below 32 F. Freezing and frozen storage of poultry will be treated in Chapter 42.

By lowering the temperature of poultry meat all possible types of deterioration are retarded whether they arise from growth of microorganisms or from chemical reactions involving the meat constituents and atmospheric oxygen. Within the range of temperatures (32 to 50 F) encountered in the commercial handling of refrigerated but unfrozen poultry, microbial deterioration is the primary problem.

With the aid of refrigeration the poultry industry has grown into a large industry, surpassed in size only by the beef and dairy industries. Broiler production has experienced remarkable growth, increasing from 350 million per year in 1945 to 1700 million head per year in 1959.

Information on classes, standards, and grades of commercial forms of poultry, as defined by the U. S. Department of Agriculture, may be obtained by writing to the Agricultural Marketing Service, Washington 25, D. C.

Processing Steps and Their Relation to Refrigeration Requirements

Methods of processing poultry vary with the kind, class and ultimate marketing form of poultry as well as with the facilities and relative concentration of poultry available in the processing area. In general, activities at processing plants include some or all of the following steps: live inspection, fattening, dispatching, defeathering, eviscerating, chilling, cutting up, packaging and freezing.

Poultry may be dispatched by severing the jugular vein or veins and by piercing the brain. Inadequate bleeding causes reddening in the skin and a lower grade for the dressed carcass. In the case of kosher killed poultry, it is essential that both jugular veins be severed as well as the esophagus and trachea. Piercing the brain is a difficult technique but when done properly loosens the feathers appreciably. An electric shock is used by some processors to stun the bird and thus prevent struggling and bruising. Use of carbon dioxide gas has been proposed by Drewniak for immobilization of poultry during slaughter.

Present commercial methods of feather removal are based on two operations, scalding and machine picking. Scalding refers to the immersion (or spraying) of the bled birds in water heated to any of several temperatures or temperature ranges. Scalding with water at 170 to 190 F, termed *hard scalding*, has a very deteriorative effect on the appearance and stability of the skin layer, and has largely been abandoned as a commercial method. Scalding at 124 F to 130 F or *semi-scalding* as it is called, loosens the feathers enough to permit picking by power-driven, rubber-fingered drums, and leaves the skin layer intact with the natural color preserved. It is essential to use semi-scalding if air chilling is contemplated. One serious economic disadvantage of semi-scalding is that the picking machines are usually not able to remove all of the pin feathers and so a great amount of costly hand labor is required to prepare the skin surface in an oven-ready condition.

To minimize labor costs, many processors have adopted *sub-scalding*, which refers to water at or around 140 F. Sub-scalding in combination with machine picking results in a completely feather-free product with the outer, epidermal layer of skin removed. Studies on the processing requirements and quality preservation connected with use of this higher (140 F) scalding temperature have been made by Pearce and Lavers, Gwin, Parnell *et al*, Pool *et al*, and Klose and Pool. The results in general support the following conclusions. Compared to a semi-scalded skin surface, the exposed surface resulting from sub-scalding is darker and more susceptible to dehydration and further darkening during chilling and storage. Therefore, it is essential to chill this product under conditions of high relative humidity such as in ice slush and to carry out all subsequent operations in a manner that will prevent moisture loss from the surface. Tight moisture-proof packaging is to be recommended.

As scalding temperatures are increased, scalding times may be reduced. It is common practice to scald at 126 F for about 60 sec and at 140 F for about 30 sec. Times in excess of those necessary to insure adequate feather removal should be avoided. Scalding at higher temperatures results in a tougher cooked skin. The relation of scalding temperature and time to toughness in the cooked flesh will be discussed in Chapter 42.

Feather picking machines are of varied design, depending properly loosens the feathers appreciably. An electric shock is used by some processors to stun the bird and thus prevent on the plant capacity and specific type of feathers to be picked. In general all machines affect feather removal through the beating and rubbing action of rubber fingers mounted on