

(100-fold) essence, is used for manufacturing, primarily for jellies. Availability of seven-fold frozen concentrate provides a more economical way of marketing high-quality strawberry juice solids. Concentrates of red raspberry, black raspberry, and blackberry juices are also available in limited quantities.

The process for preparation of strawberry and other berry juice concentrates involves essence-recovery in which 12-20 percent of the juice is separated by a stripping process using a steam injection heater. Vapors containing volatile flavors are concentrated in a fractionating column to the desired degree. The juice remaining from the essence-recovery step is concentrated under vacuum 3- to 7-fold by volume. A maximum temperature of 100 F for 2½ hr should not be exceeded for strawberry, whereas temperatures up to 130 F may be used in preparing boysenberry concentrate in a batch-type operation.

Preparation of juice for concentration involves chopping or coarse milling of cold, sound berries and mixing with pectic enzymes and filter aid. After several hours (4-5 at room temperature), juice is expressed with a bag press or rack and cloth press. The cloudy juice is clarified in a filter press. Recovered essences have been concentrated and packaged separately so that the jelly manufacturer can incorporate the essence in the jelly just before filling. This procedure reduces greatly the amount of essence lost by volatilization. The essence can also be incorporated in the concentrate to make a full-flavored product, for shipping as a single unit.

Concentrated juice, without essence, can be packed in an enamel-lined container which need only be liquid tight. Concentrated essence should be kept in a carefully sealed can to avoid losses of the highly volatile flavor. Both juice concentrate and essence are kept frozen for proper quality retention.

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FROZEN FISHERY PRODUCTS

Packaging Considerations for Freezing and Storage; Types of Packages; Freezing Methods; Calculation of Refrigeration Requirements; Storage of Frozen Fish; Effect of Composition, Temperature, Humidity, Packaging, and Glazing on Quality; Space Requirements for Frozen Fish; Transportation and Marketing

THE kinds of frozen fishery products vary with geographical location, and consist primarily of groundfish filets, scallops, breaded precooked fish sticks, and bait and animal food in the northeastern states; of round or dressed halibut and salmon, halibut and salmon steaks, groundfish filets, and bait and animal food in the northwestern states; of halibut and salmon in Alaska; of shrimp, oysters, crabs and other shellfish and crustacea in the Gulf of Mexico and south Atlantic states; and of round or dressed fish in the states bordering on the Great Lakes.

The fishery products obtained from these areas differ considerably in both physical and chemical composition. Some fish such as haddock or cod, for example, are readily adaptable to freezing and have a comparatively long storage life, while other species such as salmon tend to become rancid during frozen storage and therefore have a relatively short storage life. The differences in the composition of the many species of fish and the differences in marketing requirements necessitate consideration of the specific individual product with regard to quality maintenance and methods of packaging, freezing, cold storage, and handling.

At temperatures below freezing, bacterial activity as a cause of spoilage is somewhat limited. However, certain chemical and physical changes do occur which may eventually cause deterioration of the product. The magnitude of these changes and their effect on product quality depends upon the initial quality of the fish being frozen, the composition of the fish, the freezing method, and the frozen storage environment or combination thereof. These considerations are reflected in the four principal phases of frozen fish production and handling; namely, packaging, freezing, cold storage and transportation, described in this chapter.

PACKAGING

Packaging materials used for frozen fish are similar to those used for other frozen foods. In selecting a package three factors should be considered: (1) the effect of unit package size on the freezing and handling requirements; (2) the protection afforded the product by the package; and (3) the attractiveness and consumer appeal of the package.

Proper consideration of these factors should result in a package which will provide rapid, efficient freezing, ease of handling, adequate storage life, and product sales appeal.

Package Considerations in Freezing

Sufficient study is not always given to the type and size of package. Refrigeration equipment and packaging materials are frequently purchased without considering the effect of the package size on the freezing rate and efficiency. For example, a thin consumer package will result in a faster rate of product freezing, lower total freezing costs, higher handling costs and higher packaging material costs; a thicker institutional type package will result in a slower rate of product freezing, higher

freezing costs, lower handling costs, and lower packaging material costs. Tests conducted by the Bureau of Commercial Fisheries Technological Laboratories demonstrated these findings conclusively.

These same tests also indicated that the time required to freeze packaged fish filets in a plate freezer is directly proportional to the square of the package thickness. Thus, if it takes 180 min to freeze packaged fish filets 2 in. thick, it will take about 281 min to freeze packaged fish filets 2½ in. thick. The insulating effect of the packaging material, the fit of the product in the package and the total surface area of the package must be considered. A packaging material with a low moisture vapor permeability has an insulating effect which increases freezing time and costs. The rate of heat transfer through the packaging material is inversely proportional to its thickness; therefore, a packaging material should be used which is thin enough to produce rapid freezing, produce an adequate moisture vapor barrier in frozen storage, and thick enough to withstand heavy abuse. Aluminum foil cartons and packages offer an advantage in this regard. Proper fit of package to product is essential, otherwise the insulating effect of the air space formed will reduce the freezing rate of the product and increase freezing costs. The surface area of the package is also important because of its relation to the size of the freezer shelves or plates. Maximum utilization of freezer space can be obtained by designing the package so that it fits the freezer properly.

Package Considerations for Frozen Storage

Fishery products will lose considerable moisture and become tough and fibrous during frozen storage unless a package having a low moisture vapor permeability is used. Also, the package in contact with the product must be resistant to oils or moisture exuded from the product, otherwise rancidity of the oils and softening of the package material will occur. The package must fit the product tightly in order to minimize air spaces and thereby reduce moisture migration from product to the inside surfaces of the package.

Types of Packages

Packaging materials in general use for fishery products consist of paper board cartons coated with various waterproofing materials or laminated with moisture-vapor resistant films and heat sealable overwrapping materials having a low moisture-vapor permeability. Paper board cartons are usually made of a bleached paper board stock, which is coated with a suitable microcrystalline wax, polyethylene or other plastic material, or laminated with aluminum foil or other moisture-vapor resistant film. Microcrystalline wax coated paper board cartons are used for most fishery products. In some cases paper board cartons laminated with aluminum foil are used for specialty items where the added protection afforded and the consumer appeal warrants the extra cost. Waxed paper board