to high temperatures, produces graying very quickly, but chilling without previous heat exposure does not.

Sugar blooming of chocolate appears similar to graying or fat bloom and is caused by deposition of crystallized sugar on the surface due to condensation of moisture following removal of the candy from refrigerated storage without allowing it to temper properly. Experiments have shown that chocolate tempered by gradually raising of temperature to normal without opening the package, did not incur sugar blooming even after storage at 0 F or lower. Sugar bloom may be due also to storage in air of too high humidity, and to migration of moisture from centers to the surface. The effects of both are reduced by refrigeration.

Flavor

Retention of the original freshness of candies is one of the chief reasons for refrigerated storage. Most flavors added to candies are strong. Examples are peppermint, lemon, orange, cherry or grape, which are stable during storage. Less pronounced flavors of candy ingredients, such as butter, milk, eggs, nuts and fruits are more sensitive to high temperatures.

Low temperatures retard the development of staleness and rancidity in fats and fatty materials, preserve flavors in fruit ingredients and prevent staleness and other off-flavors of candies containing milk, eggs, gelatin, nuts and coconut. While stored at room temperature or higher for more than a few weeks, candies containing fruits become strong in flavor and those containing nuts become rancid. There are no known critical temperatures at which undesirable changes occur, but the lower the temperature the more slowly they take place. Candies containing appreciable quantities of these semi-perishable ingredients can be stored for only short periods without refrigeration.

Texture

Candy becomes increasingly soft at high temperatures and increasingly hard and brittle at low temperatures, reaching an optimum for eating at about 70 F. These changes in texture are reversible from below 0 F up to 80 F, enabling refrigerated candies to be returned satisfactorily to any desired temperature for eating. This is extremely important since the texture of most candies subjected to very low temperatures (or even shipped in contact with dry ice at about −110 F) is not permanently changed.

Most candies are manufactured at controlled temperatures. Their texture (except in hard candies and hard creams) is maintained best at temperatures below 68 F.

Insects

Candies containing fruits, chocolate, or nuts, including coconut, are favorite hosts for insects. Since fumigation and insect repellants are seldom permissible with candies, the use of refrigeration as a means of inactivating insects in candy and candy ingredients is practicable.

Common insects become active at about 50 F and activity increases as the temperature is raised to 100 F. While common cold storage temperatures do not kill many insects, they are inactivated at temperatures below 50 F. Both adults and eggs may exist for months at above freezing temperatures without feeding or propagating. Candies with insect eggs, either on the product or on the wrappers, may be held under refrigeration for long periods with no apparent damage, but when brought back to warm rooms, a serious insect infestation may develop.

There is actual killing of both adults and eggs when infested materials are stored at or near 0 F. Lower temperatures and long storage periods are lethal to insects. However, storing candies at 0 F for a few weeks usually destroys all forms of insect life.

Storage Temperature

As to their effect on candies, it is difficult to separate storage temperature from humidity, but the latter is more important. There are no critical refrigerated temperatures at which a certain type of candy must or must not be held. In general, the lower the temperature the longer the storage life, but the greater the problem of moisture condensation upon removal. Temperatures for candy storage will be considered under four practical conditions.

Air Conditioning 68 to 70 F. Since the storage of candies begins in the tempering room of the manufacturing plant, maintenance at 68 F and 50 percent rh seems desirable to prevent soft, sticky pieces from being packaged. Under these conditions all candies remain firm, and there will be little or no graying of chocolates and the original luster can be held.

Hard candies or other types containing only sugar ingredients keep in good condition for more than six months at 68 to 70 F. Other types become stale, lose original flavor and luster and most of them become darker in color. Those containing nuts or chocolate become musty or rancid on prolonged storage and the colors and flavors, even of some hard candies, may fade. Only *summer candies* should be held for more than a few weeks at 68 to 70 F or higher. This is the maximum temperature at which chocolate coated bars and packaged candies can be transported to advantage. Unless precautions are taken, the temperature of truck or rail shipments may rise to the melting point of semi-soft candies or to the graying point of chocolates. Candies temporarily stored in the sunshine or in warm places in buildings may suffer severely in loss of shape, luster, and color. Some companies use refrigerated trucks and railroad cars for hauling candies. As portable refrigerators become more generally available, their use for candies should increase and thereby supply the missing link of conditioned storage for candies from manufacturer to consumer.

Cool Storage 48 to 50 F. Experiments have shown that candies stored at this temperature remain firm, retain good texture and color, and only those containing nuts, butter, cream or other fats become stale or rancid within four months. Candies which remained practically fresh for four months were fudge, caramels, sugar bonbons, gum drops, marshmallows, lemon drops, hard creams and semi-sweet chocolates. The last named type was wrapped in aluminum foil which gave added protection. Candies which became stale at this temperature were peanut butter, taffy kisses, peanut brittle, uncovered peanut rolls, chocolate covered peanut rolls and nougat bars.

Cold Storage 32 to 34 F. Most candies can be successfully held in cold storage for one year at this temperature, and many for much longer. Only those containing nuts, coconut, chocolate or other fatty materials will become stale or rancid.

Freezer Storage 0 F or Below. The need and economic justification for freezing candies are the same as for freezing other foods—better preservation for a longer time. This method of preservation is suitable for those candies (*a*) in which very high quality standards must be maintained; (*b*) in which a longer shelf-life is desired than is accomplished from other methods of storage; (*c*) which are normally manufactured from six to nine months in advance of consumption; and (*d*) which are especially suitable for retailing as frozen items.

One of the chief reasons for freezing candies is to hold them in an unchanged condition for as long as nine months, then thaw and sell them as fresh candies. Experience shows that this is not only possible but practical. The conditions that render such a procedure economical are: (*a*) freeze only those candies that would lose quality when held at a higher temperature; (*b*) eliminate the few kinds that crack during freezing; (*c*) package the candies in moisture-proof containers similarly as other frozen foods; (*d*) thaw the candies in the unopened packages to avoid condensation of moisture on the surface.

Table 1 .... Expected Storage Life for Candy

Candy	Moisture Content %	Relative Humidity %	Storage Life—Months: Storage Temperature—F 68	48	32	0
Sweet chocolate	0.36	40	3	6	9	12
Milk chocolate	0.52	40	2	4	6	8
Lemon drops	0.76	40	2	4	9	12
Chocolate covered peanuts	0.91	40–45	2	4	6	8
Peanut brittle	1.58	40	1	1½	3	6
Coated nut roll	5.16	45–50	1½	3	6	9
Uncoated peanut roll	5.89	45–50	1	2	3	6
Nougat bar	6.14	50	1½	3	6	9
Hard creams	6.56	50	3	6	12	12
Sugar bonbons	7.53	50	3	6	12	12
Coconut squares	7.70	50	2	3	6	9
Peanut butter taffy kisses	8.20	40	2	3	5	10
Chocolate covered creams	8.09	50	1	3	6	9
Chocolate covered soft creams	8.22	50	1½	3	5	9
Plain caramels	9.04	50	3	6	9	12
Fudge	10.21	65	2½	5	12	12
Gum drops	15.11	65	3	6	12	12
Marshmallows	16.00	65	2	3	6	9

Frozen candies required moisture-proof packages. Experiments showed that candies for freezing required more protection than those for common storage, because the storage period was usually longer and there was a greater tendency for condensation upon removal. A single layer of moisture-proof material—aluminum foil, polyethylene, saran, mylar, polypropylene, cellophane, glasine or laminations including one of these—afforded adequate protection. Candies not fully protected from desiccation grained, became hard and lost flavor.

Most protection was provided when the moisture barrier was in contact with the candy in the form of a sealed, individual wrapper. Inner liners for the boxes protected candy, provided they were sealed (which was difficult and seldom accomplished). The usual manner of applying moisture barriers was as overwraps for the boxes chiefly because these were easiest to apply and seal by machines. Overwraps for boxes provided less protection than wraps for individual pieces of candy because of the relatively large amount of air enclosed within the former. For the same reason, boxes with extended edges offered less protection than did those without extended edges.

Frozen candies should be thawed in the unopened packages. While freezing, *per se*, affected only a few candies, the manner of removal from storage affected all of them, especially the candies unprotected by special coatings or individual wraps.

A few candies are improved by freezing. Candies which are improved in freshness, mellowness or rendered smoother in texture by freezing include those with high moisture content and without protective coatings or individual wrapping. Usually these are candies which are ordinarily subject to surface drying. Marshmallows, jellies, caramels, fudges, divinities, coconut macaroons, fruit loaves, coconut bonbons, panned Easter eggs, malted milk balls and chocolate puffs are in this group.

The stability of candies after freezing is good. Candies may be held frozen for six months or more, carefully thawed and then sold as fresh candies.

Some candies are prepared especially for freezing. These are made of low melting point fat, have more flavor and softer texture than most candies, and should be eaten while cold.

Humidity Requirements

Sugar ingredients are stable to a wide range of storage temperatures but are sensitive to either high or low humidity. The initial moisture content of candies determines to a great extent the optimum relative humidity of the storage atmosphere. Candies with moisture content of 12 to 16 percent—marshmallows, gum drops, coconut sticks, jelly beans and fudge—should be stored at 60 to 65 percent rh to avoid becoming sticky, runny or moldy on the one hand, or hard and crusty on the other. Candies with moisture content of 5 to 9 percent which include most fine candies, nougat bars, nut bars, hard and soft creams, bonbons and caramels should be stored at 50 to 55 percent rh to retain the original weight, finish and texture. Candies with moisture content below 2 percent—milk chocolate bars, chocolate covered nuts and all kinds of hard candies—should be stored at 45 percent rh or lower.

The hygroscopicity of the ingredients also determines the relative humidity at which candies must be held to retain the original firmness and finish. Candies with a high proportion of invert sirup, as taffy kisses, must be kept in a very dry place, even though the moisture content is not extremely low. Other candies containing high proportions of invert sirup, honey or corn sirup, must be held in a drier atmosphere than the moisture content indicates.

Table 1 shows the expected storage life of 18 representative candies when stored at the recommended humidities and at four temperatures.

Candies stored at low temperatures have a wider range of critical relative humidities than when stored at high temperatures. For example, nougat bars stored at 65 percent rh (which is 10 percent too high) will become sticky within a few days at room temperature, but at 40 F or lower, stickiness might not show up for many weeks. Likewise, marshmallows stored in a room with 55 percent rh (which is 10 percent too low) will become dry and crusty within a few days at room temperature, but if stored at 40 F or lower, would show little change for several weeks. Thus, refrigeration retards or delays the ill effects of storing under improper humidity conditions. Humectants, such as high conversion corn sirup, are advantageous for maintaining original moisture content of certain candies.

Cost of Storage of Candies

A survey of 41 refrigerated warehouses in the United States shows that the average tariff for the storage of a ton of candy for 9 months is $49.52 at 32 F and $59.84 at 0 F (Table 2). This includes handling in and out of the warehouse as well as storage. At 32 F the cost of handling in and out of storage is $5.24, and the storage rate is $4.92 per month; at 0 F the cost of handling into (which includes freezing) and out of storage is $10.52, and the storage rate is $5.58 per month.

NUTS

Nuts that are refrigerated, in order of importance, are peanuts, walnuts, pecans, almonds, filberts, chestnuts, and imported cashew and brazil nuts. The advantages of refrigerated storage of nuts are: (a) the merchantable life is increased as