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Practices in Handling and Storing Commercially Frozen Food in Ohio Households

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INTRODUCTION

Freezing provides a popular means of preserving desirable qualities in food products. Because of the sensitivity of frozen food to fluctuations in temperature, practical means of maintaining high, or at least acceptable, quality from processing to use is an important concern of the frozen food industry. Much time and effort have been devoted to study of the problems involved.

Through carelessness or ignorance, the consumer has as much or more opportunity to cause deterioration in quality of the commercially frozen food purchased as any handler in the distribution channels. The work reported here[1] deals with practices in handling commercially frozen food in households in Ohio. Implications of these practices for maintenance of quality are considered.

PROCEDURE

The Sample

Information on practices in handling and storing commercially frozen food was obtained from 2844 Ohio homemakers in a mail survey and by personal interviews. Samples for both the mailed questionnaires (8000) and interviews (400) were selected by a random-ordered or systematic sampling method to be proportional to the distribution of households among Ohio's densely populated sections, moderate-sized cities and towns, and rural areas. The areas covered are shown in Figure 1.

The interview group served in part as a control group with which distribution of the response by mail could be compared and in part as a source of supplementary information, particularly on type of refrigeration used by families for frozen food storage and storage temperatures maintained. A more detailed explanation of the sampling procedure has been reported (8).

The Questionnaire

The questionnaire used for both the mail and the interview samples was developed to collect information of three general types from consumers: (a) extent of home use and acceptance of commercially frozen food products, (b) care afforded products purchased, and (c) problems encountered in purchasing and using these items. Information dealing with (a) and (c) has been reported (7, 8).

The section of the questionnaire on care of frozen foods was based largely upon recommendations by Tressler and Evers (14), consumer information released by the U. S. Department of Agriculture (2), and suggestions published by the Ohio Cooperative Extension Service (4). Some questions suggested by the National Association of Frozen Food Packers also were included.

The Interviews

At the beginning of each interview with a homemaker who used frozen food, the interviewer requested permission to measure the temperature of the freezing section of the appliance used for storage of commercially frozen food in the home. In cases where both a conventional refrigerator or a combination refrigerator-freezer and a separate freezer were owned, the temperature measurement was made in the appliance in which the major share of purchased frozen food was stored.[2] These temperature measurements were intended to provide a gross estimate of conditions under which frozen foods were being stored in homes.

The thermometer was inserted between packages of food so that it was in contact with the food packages and not touching the walls of the compartment or suspended in air. It was left in the freezing compartment until near the completion of the interview (about ½ hour) if the situation permitted; otherwise, for a minimum of 5 minutes. Temperatures were not measured if the compartment was empty, if warm food had just been put into it, if the appliance was being manually defrosted, or if the homemaker objected.

No attempt was made to record make or model, age, extent of frost accumulation, or the coldness setting in use in the appliance.

[1]Information in this report was obtained as part of the work on Hatch Project 250, Practices of Ohio Families in Procurement, Storage, and Use of Frozen Foods. The study was supported in part by a grant from the National Association of Frozen Food Packers to the Ohio Agricultural Research and Development Center.

[2]Weston dial thermometers supplied by Weston Instruments Division, Daystrom, Inc., were used for this purpose.

Analyses of Data

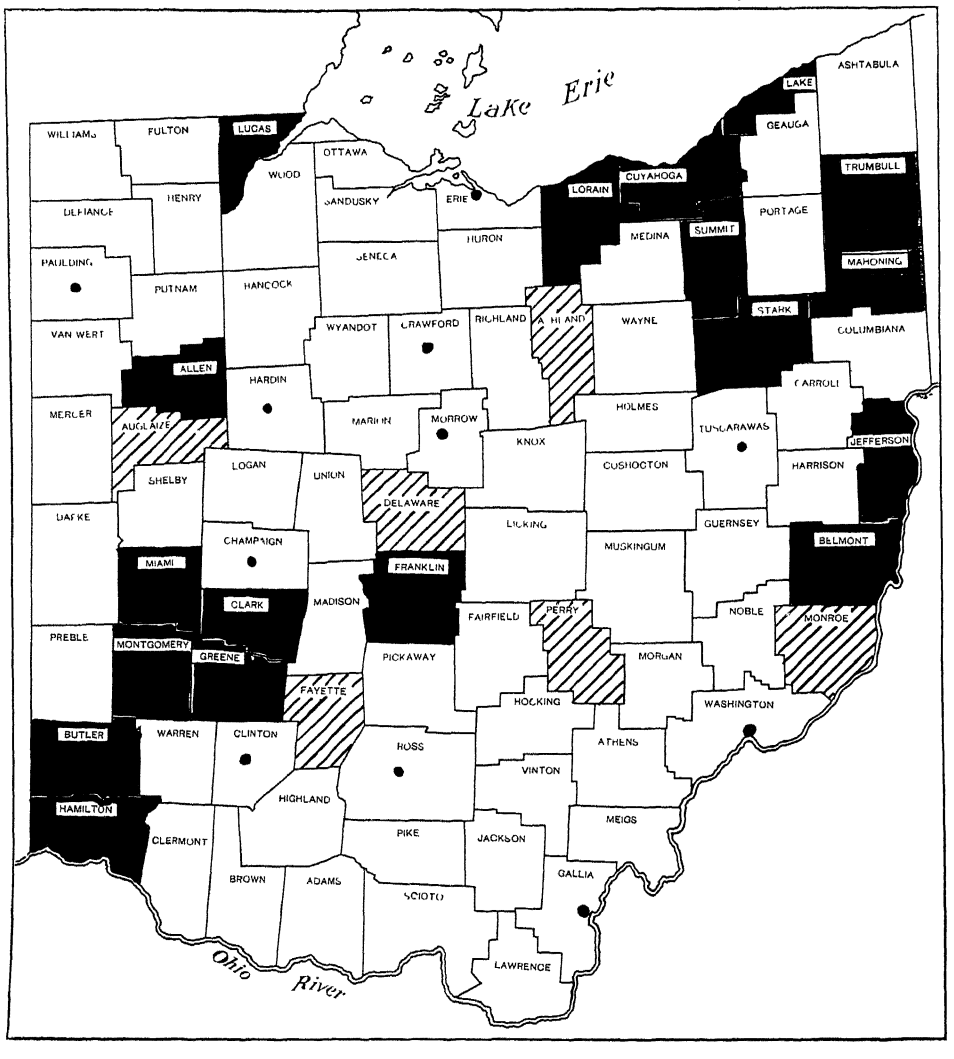
Information obtained on storage of various frozen items was classified by background factors such as place of residence, type of freezing storage unit used, and number in the household. Tests of association (chi square) were made to determine whether or not storage practices with frozen food items were related to these background factors.

RESULTS AND DISCUSSION

In the survey of practices of Ohio families in procurement, storage, and use of frozen food, usable responses were obtained from 3005 households; 2670 by mail and 335 by interview. Among the cooperators, 149 (5 percent) reported that they used no commercially frozen food. This portion of the samples was therefore eliminated from these analyses. Of the 2856 respondents who said that they used commercially frozen food, 2844 provided information on handling and storage practices.

Characteristics of the Sample

The samples drawn and responding are shown in Table 1, distributed by location of residence. Response tended to be associated at the 5 percent level with location. In proportion to the distribution of the original sample, a slightly higher percentage of usable returns was received from the rural and town groups than from those in cities.



Key:
- ■ Urbanized areas (Central cities with population of 50,000 or more plus urban fringes)
- • Other urban (Places with population of between 2,500 and 50,000)
- ▨ Rural (Counties with population under 50,000 and excluding places of 2,500 or more)

Fig. 1.—Areas included in samples selected for personal interviews and the mailed questionnaires.

TABLE 1.—Distribution of Sample and Responses by Location.

Location	Sample			
	Drawn		Responding	
	No.	%	No.	%
City	5044	60	1724	57
Town	1266	15	473	16
Rural	2098	25	808	27
Total	8408	100	3005	100

$X^2 = 6.4991$; $0.05 > P > 0.02$.

TABLE 2.—Distribution of Responses by Location and Data Collection Method (Users and Non-users).

Location	Mailed Questionnaire		Interview		Total
	No	%	No.	%	
City	1527	57	197	59	1724
Town	418	16	55	16	473
Rural	725	27	83	25	808
Total	2670	100	335	100	3005

$X^2 = 0.8718$; $0.70 > P > 0.50$.

Distribution of responses by location (Table 2) was not related to method of collection of data. Since the samples were selected by a random-ordered or systematic sampling method stratified by location and since distribution of the responses was not associated with the method of data collection, findings from the mailed questionnaire and interviews were combined as one sample for most of the analyses. Information on temperatures in freezing storage units in the home was available from the interview sample only and this is treated separately.

Characteristics of the sample are summarized in Table 3. In 75 percent of the households represented, there were two to five members. Annual incomes (gross) of between $4,000 and $8,000 were reported in nearly half of the returns.

Freezing Storage Units for Storage of Commercially Frozen Food in Homes: Sixty-five percent of the families stored the major part of their frozen food purchases in either a combination refrigerator-freezer or a separate food freezer and 23 percent used a conventional refrigerator only. Distribution of responses by location of the cooperator and by type of freezing storage unit is shown in Table 4.

Nearly two-thirds of the rural households owned food freezers compared to about one-fourth of those in cities and nearly one-third of those in towns. These figures for rural households in Ohio are similar to

TABLE 3.—Distribution of Responses by Background Factors (Users and Non-users).

Background Factors	No.	Percent
Type of Freezing Storage Unit		
Conventional refrigerator	702	23
Combination refrigerator-freezer	857	29
Separate freezer	1078	36
Rental locker	56	2
Other	133	4
No data	167	6
Total	3005	100
Number in Household (persons)		
1	35	1
2	637	21
3	553	18
4	632	21
5	439	15
6	232	8
7 or more	201	7
No data	276	9
Total	3005	100
Annual Income (gross)		
$1,999 and less	70	2
$2,000 to $3,999	261	9
$4,000 to $5,999	794	26
$6,000 to $7,999	618	21
$8,000 to $9,999	342	11
$10,000 or more	452	15
No data	468	16
Total	3005	100

TABLE 4.—Distribution of Responses by Location and by Type of Freezing Storage Unit Used for Commercially Frozen Food.

Type of Freezing Storage Unit	Location						Total	
	City		Town		Rural			
	No.	%	No.	%	No.	%	No.	%
Conventional refrigerator	477	28	119	25	106	13	702	23
Combination refrigerator-freezer	627	36	150	32	80	10	857	29
Freezer	424	25	146	31	508	63	1078	36
Rental locker	9	1	13	3	34	4	56	2
Other	78	5	14	3	41	5	133	4
No data	109	6	31	7	39	5	179	6
Total	1724	101	473	101	808	100	3005	100

TABLE 5.—Distribution of Responses by Income Level of Family and by Type of Freezing Storage Unit Used for Commercially Frozen Food.

Annual Income (gross)	Type of Freezing Storage Unit											
	Conventional Refrigerator		Combination Refrigerator-Freezer		Freezer		Rental Locker		Other		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
$ 1,999 and less	20	27	17	23	35	47	2	3	1	1	75	101
$ 2,000 to $3,999	66	27	56	23	98	41	8	3	13	5	241	99
$ 4,000 to $5,999	213	29	175	24	307	41	19	3	27	4	741	101
$ 6,000 to $7,999	169	28	202	34	190	32	10	2	23	4	594	100
$ 8,000 to $9,999	66	20	112	34	120	37	4	1	24	7	326	99
$10,000 or more	74	17	159	36	174	40	3	1	30	7	440	101
Total	608	25	721	30	924	38	46	2	118	5	2417	100

$X^2 = 67.212$; $P < 0.001$.

those reported by the U. S. Department of Agriculture (1) but percentages for urban dwellings are about double those reported for this group in the nation in 1960 (13). In households reporting separate food freezers, conventional refrigerators were generally used for a few frozen items for temporary storage.

About one-third of the city and town cooperators reported use of a combination refrigerator-freezer for storage of the major part of purchased frozen food, compared to one-tenth of the rural dwellers surveyed.

Distribution of responses by type of freezing storage unit used and by gross annual family income is shown in Table 5. The type of freezing storage unit used was significantly associated (1 percent level) with income level of the family. Use of the combination refrigerator-freezer tended slightly to be associated with incomes of more than $6,000 and use of conventional refrigerators as the only frozen food storage space with income levels below $8,000. Ownership of separate food freezers did not appear to be associated with any particular income level.

TABLE 6.—Use of Frozen Food Items by Households in Ohio During 1 Week, Autumn 1962 (Total Households = 2844).

Frozen Food Item	Number of Packages				Total No. Users	Percent Using
	None	1	2	3 or More		
	Number of Responses					
Juice concentrates	1026	214	360	1244	1818	64
Regular vegetables	1030	364	476	974	1814	64
Potato products	1693	502	383	266	1151	40
Fish sticks	2075	511	129	129	769	27
Meat	2075	142	114	513	769	27
Other fish and seafood	2117	454	134	139	727	26
Poultry	2122	366	180	176	722	25
Other baked products	2166	280	159	239	678	24
Potpies	2251	79	111	403	593	21
Dinners	2278	82	143	341	566	20
Fruit	2270	245	161	168	574	20
Dessert pies	2263	322	125	134	581	20
Miscellaneous prepared items	2421	220	108	95	423	15
Pre-seasoned vegetables	2532	154	67	91	312	11

Extent of Use of Frozen Food

The extent of use of commercially frozen food by families in Ohio during the survey week is shown in Table 6 and is reported in greater detail elsewhere (8). Fruit juice concentrates and vegetables were by far the most popular groups of items and were reported used by equal percentages of cooperators. The least extensively used items were pre-seasoned vegetables. At the time of the survey, the latter were a relatively new item on the market in many Ohio communities and sufficient time may not have elapsed since their introduction for the gaining of acceptance.

Numerous cooperators commented during interviews that lack of appropriate storage space for frozen food was a deterrent to their purchase of commercially frozen items. A common practice was the buying of groceries on payday—twice a month. Quantities of meat sufficient to last a household for a 2-week period were commonly purchased at that time and stored in the freezing section of the refrigerator. In many cases, this left little if any space for commercially frozen items.

Length of Storage of Frozen Food

Respondents to the questionnaire indicated the longest usual storage periods in their households for various frozen food items. These responses are summarized by item and storage period in Table 7. Nearly half of those indicating storage periods for juice concentrates reported holding these for no longer than 2 weeks. About three-fourths stored this item for a maximum of 1 month.

Maximum storage periods for vegetables varied slightly with type of vegetable and degree of pre-

TABLE 7.—Distribution of Responses by Frozen Food Item and by Estimated Longest Usual Storage Period.

Frozen Item	Longest Usual Storage Period												
	7 Days or Less		8 to 14 Days		15 to 30 Days		31 to 90 Days		91 to 180 Days		More than 180 Days		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
Potatoes	322	20	412	26	452	28	288	18	107	7	30	2	1611
Regular vegetables	283	14	460	23	527	27	366	18	214	11	129	6	1979
Pre-seasoned vegetables	135	29	103	22	107	23	75	16	41	9	10	2	471
Fruit	190	16	171	15	222	19	182	16	214	18	188	16	1167
Fruit juice	400	23	427	24	434	25	269	16	153	9	57	3	1740
Poultry	308	23	225	17	279	21	253	19	184	14	67	5	1316
Meat	263	19	281	20	255	18	214	16	206	15	157	11	1376
Fish sticks	391	36	264	24	252	23	130	12	48	4	5	—	1090
Other seafood	304	28	213	20	291	27	177	16	79	7	24	2	1088
Dinners	301	34	194	22	211	24	129	14	44	5	8	1	887
Potpies	249	26	219	23	234	25	175	19	53	6	10	1	940
Dessert pies	302	32	177	19	196	21	162	17	73	8	21	2	931
Other baked products	296	28	263	25	267	26	147	14	49	5	15	1	1037
Miscellaneous prepared items	206	32	134	20	178	27	88	14	40	6	7	1	653

preparation. Unseasoned vegetables such as peas and green beans usually were retained the longest.

Percentages of cooperators reporting maximum holding periods of 6 months or longer were higher for fruit and meat, 16 and 11 percent, respectively, than for any other commodities.

Poultry was stored by similar percentages (17 to 23 percent) of respondents for periods of 1 week or less, 1 to 2 weeks, 2 weeks to 1 month, and 1 to 3 months. A maximum storage period of 3 months for this item was reported by 80 percent of the respondents.

Redstrom *et al.* (10) found that few households in either Baltimore or Indianapolis stored any commercially frozen foods for longer than 2 weeks. In the Ohio study, many families reported storage of frozen items for as long as 1 month but few having access only to a conventional refrigerator reported storage periods of longer than this. Differences in findings in the two studies may be due in part to differences in the sample. The former included only urban families; the latter, both urban and rural. In addition, Redstrom *et al.* based their conclusions on longest storage periods reported for food used during the survey week. In the present study, cooperators were asked to estimate their "longest usual" storage periods for the various items or food groups listed.

Factors Associated with Length of Storage of Frozen Food

Length of storage of all frozen food items listed in the questionnaire was tested (chi square) for association with location of residence, type of freezing storage unit used, and number of persons in the household. The chi square values for food items by background factors are summarized in Table 8.

TABLE 8.—Levels of Association of Storage Period for Frozen Food Items with Household Size, Freezing Storage Unit, and Location of Residence.

Frozen Item	Household Size		Freezing Storage Unit		Location of Residence	
	X^2 Value	Level of Significance*	X^2 Value	Level of Significance†	X^2 Value	Level of Significance‡
Potato products	29.7995	$.50 > P > .30$	607.9310	$P < .001$	13.2405	$.20 > P > .10$
Regular vegetables	38.3649	$.20 > P > .10$	582.4955	$P < .001$	97.7234	$P < .001$
Pre-seasoned vegetables	31.8288	$.50 > P > .30$	88.9837	$P < .001$	23.0842	$.01 > P > .001$
Fruit	36.0311	$.30 > P > .20$	253.0073	$P < .001$	97.2212	$P < .001$
Fruit juice	20.7061	$.90 > P > .80$	431.8981	$P < .001$	28.5105	$P < .001$
Poultry	18.2212	$.98 > P > .95$	370.1706	$P < .001$	52.3114	$P < .001$
Meat	34.6615	$.30 > P > .20$	547.2070	$P < .001$	93.1922	$P < .001$
Fish sticks	31.5899	$.50 > P > .30$	191.6900	$P < .001$	36.3913	$P < .001$
Other fish and seafood	21.4771	$.90 > P > .80$	193.4670	$P < .001$	27.2322	$P < .001$
Dinners	21.3305	$.90 > P > .80$	201.6838	$P < .001$	11.2037	$.20 > P > .10$
Potpies	11.7904	$P > .99$	186.5490	$P < .001$	19.7931	$.02 > P > .01$
Dessert pies	23.4584	$.80 > P > .70$	306.8292	$P < .001$	30.4183	$P < .001$
Other baked goods	21.1134	$.90 > P > .80$	159.1970	$P < .001$	38.5937	$P < .001$
Miscellaneous prepared items	29.0642	$.70 > P > .50$	112.4936	$P < .001$	17.8337	$.05 > P > .02$

*df = 30; †df = 16; ‡df = 8.

Type of Freezing Storage Unit: Length of storage of all frozen food items included in the survey was significantly associated with type of freezing storage space available (Table 8.) In general, there was a tendency for items to be stored for longer periods by those having food freezers and for shorter periods (2 weeks or less) by those owning conventional refrigerators only. Even so, every item except prepared dinners and potpies was reported held in a conventional refrigerator by a few respondents for periods of 6 months or longer.

Among the cooperators having only a conventional refrigerator in which to store frozen food, 90 percent or more reported retention of all items except fruit (87 percent) for no longer than 1 month (Table 9). Fifty percent or more of the respondents having this type of refrigeration and reporting on storage periods used dessert pies, fish sticks, dinners, poultry, and miscellaneous prepared items within 1 week of purchase. All other items were used within this relatively short period of time by 30 to 47 percent of the cooperators reporting use and storage periods.

Seventy-five percent or more of those having a combination refrigerator-freezer used all frozen food purchases except fruit (62 percent) within 1 month. About one-third or more did not retain baked products other than pies, dessert pies, dinners, or fish sticks for longer than 1 week.

Owners of food freezers were more variable in storage practices than either of the other two groups. Among those reporting storage periods, 20 to 70 percent retained specific products for 1 month or less. Fish sticks were most often (70 percent) reported stored for no longer than 1 month and fruit (20 percent) was the least often so reported. Among the group of respondents having freezers, about 20 percent held fish sticks, dinners, pre-seasoned vegetables, or miscellaneous products for 1 week or less. Smaller percentages used the remaining items listed in the questionnaire 1 week or less after purchase.

From these findings on length of storage as affected by type of storage space, fish sticks and other of the more nearly completely prepared types of frozen food appeared to be purchased more often than others for immediate use. Owners of only conventional refrigerators most often used these within 1 week.

Number of Persons in the Household: Storage periods were not associated with family size for any of the frozen food items (Table 8.) The supposition had been made that larger families would need to use larger quantities of the frozen items and, with a limited amount of storage space, the storage time would tend to be short. In fact, however, the households large enough for lack of space to be much of a factor in length of storage tended to use fewer frozen items than smaller families (8).

Location of Residence: Location of the household was significantly associated with length of storage for all items except potato products and frozen dinners. Seventy-four percent of the respondents reported that potatoes were not likely to be stored for longer than 1 month and 80 percent did not store dinners longer than this. For all remaining items, larger percentages of rural households than of urban reported holding periods exceeding 1 month. This is not surprising in view of the fact that larger percentages of rural than urban families owned separate food freezers and thus may have had more suitable space available for longer storage.

TABLE 9.—Distribution (Percent) of Responses by Frozen Food Items, Specified Periods of Storage, and Freezing Storage Space.

Food Item	Conventional Refrigerator			Combination Refrigerator-Freezer			Freezer		
	Total	30 Days or Less	7 Days or Less	Total	30 Days or Less	7 Days or Less	Total	30 Days or Less	7 Days or Less
	No.	%	%	No.	%	%	No.	%	%
Potato products	404	94	36	538	80	18	521	48	11
Regular vegetables	483	91	30	642	75	13	711	36	5
Pre-seasoned vegetables	119	90	42	168	80	27	149	51	20
Fruit	267	87	34	363	62	17	445	20	5
Juice concentrates	442	91	36	563	80	25	610	53	12
Poultry	277	93	51	405	78	25	535	33	7
Meat	291	87	39	454	78	22	534	27	6
Fish sticks	291	96	58	322	87	32	404	70	23
Other fish and seafood	237	94	47	334	81	30	432	58	16
Dinners	236	97	53	282	85	33	300	59	20
Potpies	240	94	47	280	79	25	346	58	13
Dessert pies	212	97	62	297	86	34	361	47	13
Other baked products	199	93	46	338	88	36	433	66	15
Miscellaneous prepared items	146	96	51	235	84	29	229	62	20

Temperatures in Freezing Storage Units

Temperatures in freezing storage units were recorded in 222 homes. The distribution among types of units was as follows: conventional refrigerators, 86; combination refrigerator-freezers, 69; and freezers, 67. This distribution was not proportional to ownership in the interview group but merely represents units to which the interviewers were allowed access for measuring temperature and which fit the criteria for measurement as outlined in the procedure.

Distribution of recorded temperatures by type of appliance is shown in Table 10 and Figure 2. Temperatures as low as — 5° F. and as high as 30° F. were found in conventional refrigerators but most were within the range of 4° to 23° F. Twenty-eight percent were at temperatures of 10° F. or below; nearly half registered within the range of 11° to 20° F.; and nearly one-fourth, above 20° F. The median temperature for conventional refrigerators was 15° F.

In combination refrigerator-freezers, the lowest temperature recorded was — 10° F. and the highest, 25° F. Eighty-three percent were at 10° F. or below but only 27 percent registered at or below 0° F. For these freezing storage units, the median temperature was 4° F.

The lowest temperature measured in home freezers was -- 11° F. and the highest was 10° F. Most registered at 0° F. ± 5°. In fact, 63 percent of the freezer temperatures were at 0° F. or lower and 0° F. was the median temperature for freezers.

These median temperatures are similar to those usually quoted by manufacturers for the corresponding types of household freezing units.

Length of Storage Periods for Frozen Food at Storage Temperatures Recorded in Homes

Maximum lengths of storage reported for various frozen food items and storage temperatures recorded in 222 Ohio households are shown in Table 11. At storage temperatures of 21° F. or above, practically all of the meat, poultry, fish, and the more nearly completely prepared items were used within a period of 1 week. A few items were reported held for as long as 1 month at 21° F. and above but none for longer periods. In most cases, items kept for longer than 1 week were vegetables, fruit, or fruit juice concentrates.

Longest usual storage periods within a given temperature range reported for any frozen food are

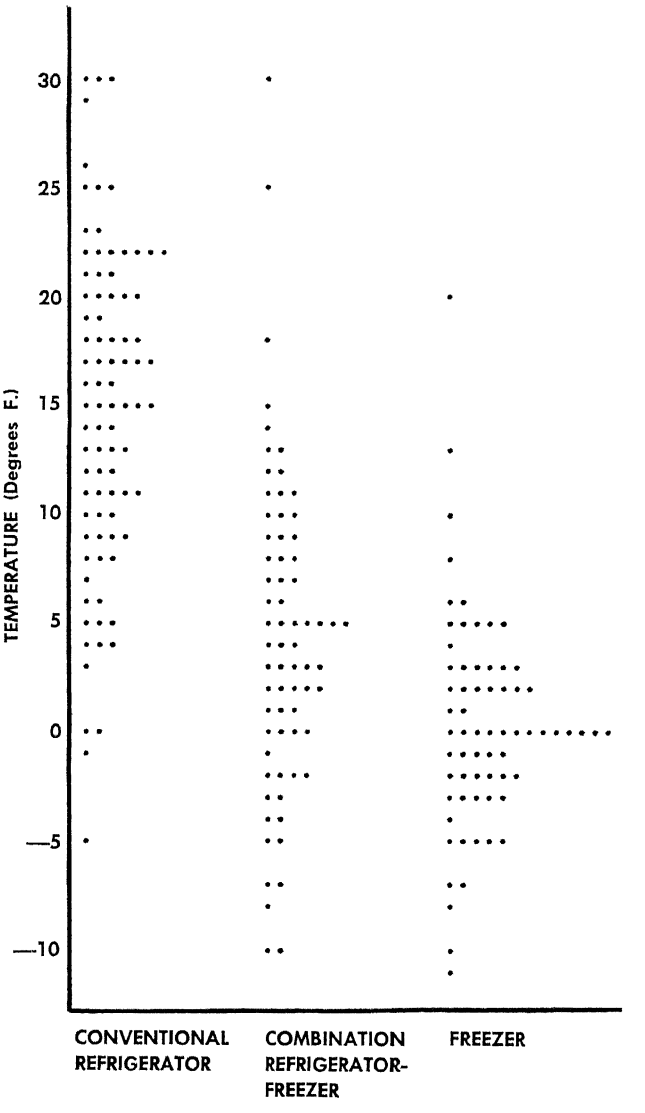


Fig. 2.—Temperatures recorded in freezing storage units in homes.

TABLE 10.—Distribution of Temperatures Recorded by Type of Freezing Storage Unit.

Freezing Storage Unit	Temperature								Total	
	0° F. and Below		1° to 10° F.		11° to 20° F.		21° F. and Above			
	No.	%	No.	%	No.	%	No.	%	No.	%
Conventional refrigerator	4	5	20	23	42	49	20	23	86	100
Combination refrigerator-freezer	20	29	37	54	10	14	2	3	69	100
Freezer	40	60	25	37	2	3	—	—	67	100
Total	64	29	82	37	54	24	22	10	222	100

TABLE 11.—Distribution of Responses by Maximum Length of Storage of Frozen Food Items and Temperature Ranges Recorded (Total = 222).

Storage Temperature Range (Degrees F.)	Maximum Length of Storage						
	7 Days or Less	8 to 14 Days	15 to 30 Days	31 to 90 Days	91 to 180 Days	More than 180 Days	Total
				Potato Products			
0 and below	6	11	13	5	3	1	39
1 to 10	14	14	14	5	2	0	49
11 to 20	15	7	5	2	0	0	29
21 and above	10	2	2	0	0	0	14
Total	45	34	34	12	5	1	131
				Regular Vegetables			
0 and below	4	16	10	14	5	1	50
1 to 10	11	21	19	12	7	1	71
11 to 20	11	21	10	3	0	0	45
21 and above	9	1	5	0	0	0	15
Total	35	59	44	29	12	2	181
				Pre-seasoned Vegetables			
0 and below	0	5	4	3	0	0	12
1 to 10	4	3	4	2	1	0	14
11 to 20	2	2	1	1	0	0	6
21 and above	3	1	1	0	0	0	5
Total	9	11	10	6	1	0	37
				Fruit			
0 and below	3	6	4	12	9	1	35
1 to 10	10	12	19	10	3	0	54
11 to 20	11	12	7	1	0	1	32
21 and above	10	1	4	0	0	0	15
Total	34	31	34	23	12	2	136
				Fruit Juice Concentrates			
0 and below	8	13	11	7	7	1	47
1 to 10	21	17	15	10	6	1	70
11 to 20	13	18	5	4	0	0	40
21 and above	8	3	4	0	0	0	15
Total	50	51	35	21	13	2	172
				Poultry			
0 and below	4	8	6	6	4	1	29
1 to 10	14	9	13	6	2	2	46
11 to 20	13	4	5	1	1	0	24
21 and above	5	0	1	0	0	0	6
Total	36	21	25	13	7	3	105
				Meat			
0 and below	5	10	6	3	3	3	30
1 to 10	14	15	14	4	5	2	54
11 to 20	9	9	8	0	2	1	29
21 and above	5	0	1	0	0	0	6
Total	33	34	29	7	10	6	119

TABLE 11. (Continued)—Distribution of Responses by Maximum Length of Storage of Frozen Food Items and Temperature Ranges Recorded (Total = 222).

Storage Temperature Range (Degrees F.)	Maximum Length of Storage						
	7 Days or Less	8 to 14 Days	15 to 30 Days	31 to 90 Days	91 to 180 Days	More than 180 Days	Total
				Fish Sticks			
0 and below	9	11	10	4	3	0	27
1 to 10	16	17	13	3	1	0	50
11 to 20	16	9	4	0	0	0	29
21 and above	14	1	1	0	0	0	16
Total	55	38	28	7	4	0	132
				Other Fish and Seafood			
0 and below	9	7	10	5	3	0	34
1 to 10	15	11	19	4	1	0	50
11 to 20	12	9	5	1	0	1	28
21 and above	12	1	0	0	0	0	13
Total	48	28	34	10	4	1	125
				Dinners			
0 and below	5	7	8	8	1	0	29
1 to 10	14	15	10	3	0	0	42
11 to 20	13	7	3	1	0	0	24
21 and above	7	1	1	0	0	0	9
Total	39	30	22	12	1	0	104
				Potpies			
0 and below	8	8	5	7	1	0	29
1 to 10	11	10	14	4	3	0	42
11 to 20	12	1	3	1	0	0	17
21 and above	12	0	0	0	0	0	12
Total	43	19	22	12	4	0	100
				Dessert Pies			
0 and below	5	5	6	3	3	1	23
1 to 10	15	10	15	4	3	0	47
11 to 20	18	6	4	1	1	0	30
21 and above	8	0	1	0	0	0	9
Total	46	21	26	8	7	1	109
				Other Baked Products			
0 and below	6	11	9	2	2	0	30
1 to 10	6	11	11	4	0	0	32
11 to 20	11	8	3	1	0	0	23
21 and above	6	1	0	0	0	0	7
Total	29	31	23	7	2	0	92
				Miscellaneous Prepared Items			
0 and below	3	5	6	4	3	0	21
1 to 10	10	4	6	2	0	0	22
11 to 20	5	7	1	0	1	0	14
21 and above	5	0	1	0	0	0	6
Total	23	16	14	6	4	0	63

TABLE 12.—Distribution of Responses by Storage Temperature and by Longest Usual Storage Period for Any Item.

Storage Temperature	Longest Usual Storage Period								
	No Data	Use Immediately	7 Days or Less	8 to 14 Days	15 to 30 Days	31 to 90 Days	91 to 180 Days	More than 180 Days	Total
21° F. and above	2	2	7	2	9	—	—	—	22
11° to 20° F.	2	1	10	18	15	6	1	1	54
1° to 10° F.	2	—	9	7	29	17	14	4	82
0° F. and below	5	—	2	10	11	7	17	12	64
Total	11	3	28	37	64	30	32	17	222

summarized in Table 12. The data tend to reflect an awareness on the part of householders of the limitations of the refrigerating appliance in use; i. e., at the higher temperatures, storage periods were shorter than at the lower temperatures.

In cases in which supplies of unfrozen meat and poultry are stored in freezing compartments at temperatures of 20° F. or slightly above, large ice crystals are likely to form and considerable free water in the food remains unfrozen (3, 11). Neither condition is considered desirable for long-term storage (5).

With food frozen and stored at 0° F. and later transferred to temperatures of 20° F. or slightly above, a period of several hours would elapse before the food reached the temperature of the new environment. If microorganisms were present which could grow at temperatures this low, a lag in time might be expected before such growth would be initiated (6, 12). At these temperatures, generation times also are likely to be fairly long (9).

Some detriment to quality, but not necessarily to wholesomeness of frozen food, can occur during short storage periods with increase in storage temperatures from 0° F. or below to higher freezing temperatures. Structural damage to tissue can occur, caused by migratory recrystallization in which small crystals tend to disappear and larger crystals grow correspondingly larger in the food with temperature fluctuations.

In this study, as in the Baltimore and Indianapolis survey (9), the conclusion is probably justified that quality deterioration would be negligible for these relatively short holding periods at freezing temperatures considered unfavorable for storage of frozen food products. In such a conclusion, however, the assumption is made that the food was solidly frozen when placed in the freezing unit, had been processed under sanitary conditions, and had been held under ideal storage conditions (0° F. or lower) previous to purchase and storage in the home.

Practices in Buying and Handling Frozen Food

Recommendations for purchase and home care of frozen food include: select clean, firm packages; avoid torn, crushed, or juice-stained packages; select frozen food last during grocery shopping in order to shorten exposure time at unrefrigerated temperatures; and protect unrefrigerated food with double or insulated paper bags during transport from grocery to home (2). The last two points also imply the need for haste in getting frozen items into freezing storage at home. Some consumer information materials

TABLE 13.—Distribution of Responses to Questions About Practices in Buying and Using Frozen Food.

Question	Response				Total
	Yes		No		
	No.	%	No.	%	
After grocery shopping, do you feel that you need to hurry home to refrigerate the frozen foods you have bought?	1691	60	1130	40	2821
Do you sometimes refreeze thawed or partly thawed foods?	909	32	1900	68	2809
Would you buy a juice-stained package of frozen food?	148	5	2610	95	2758
Do you sometimes leave a package of frozen food to thaw at room temperature for more than 2 hours?	1806	64	1013	36	2819
When buying groceries, do you select the frozen foods you want at the beginning of the trip through the store?	335	12	2445	88	2780
Would you buy a package of frozen food having a cut or torn wrapper if the food seemed solidly frozen?	472	17	2327	83	2799
When you buy frozen foods, does the clerk place them together in a separate bag for you?	1740	62	1045	38	2785
If not, would you prefer that he do so?	1091	90	118	10	1209
When you have a partially used package of frozen food in your freezer, do you try to use it within a certain length of time?	1954	77	587	23	2541

warn against refreezing partially or completely thawed food (4). Others point out that a loss in quality in the food will occur but that some foods under certain thawing conditions may be safely refrozen (2).

In preparing frozen food for cooking, thawing is generally recommended for meat, fish, poultry, and some vegetables, such as spinach, squash, and corn-on-the-cob, in order to obtain more uniform doneness in the cooked product (14). Pre-thawing of casseroles is left to the discretion of the user. Warnings are given that thawed food should not be held for long periods before cooking.

Responses to questions designed to reveal consumer practices in care and handling of frozen food in view of recommendations are presented in Table 13. Sixty percent of the respondents reported feeling some sense of urgency about getting their frozen food purchases home and refrigerated. Only a slightly larger percentage (62 percent) of the women said that their grocer provided special insulating wrapping for these items. Of those who did not receive this service, 90 percent said they wanted it.

Twelve percent of the cooperators said they picked up the frozen items during the early part of their trip through the grocery store. During interviews, those who did this generally reported that the layout of the store they patronized placed frozen food items in this order in the traffic flow pattern and that it was easier and quicker to pick up items as they passed rather than to come back to the area.

Juice-stained packages of frozen food may indicate temperature abuse of the item and 95 percent of the cooperators said they would not buy such an item. On the other hand, cut or torn packaging materials could permit drying of food, contamination, or both, but only 83 percent of the cooperators indicated that they would refuse to buy food in packages having this kind of damage.

Nearly one-third of the respondents reported that they sometimes refroze partially or completely thawed food. During interviews, several women answered this question with a question, "You aren't supposed to do that, are you?" Others indicated that they were confused about whether or not and when refreezing was a safe practice.

A few women reported they had discarded items in the past which appeared to have been thawed and refrozen before purchase or when the food started to thaw on the way home from the store. Others threw out vegetables which appeared "dried out" and a few reported they were afraid to use food coated with ice crystals.

Distribution of responses to the above items, as well as the problems listed by cooperators (7) and questions asked informally, indicate a continuing need for educational materials on handling, freezing, and storing frozen food.

SUMMARY AND CONCLUSIONS

Information on practices in handling and storing commercially frozen food was obtained from 2844 cooperators in a survey of practices in procurement, storage, and use of frozen food in households in Ohio. Factors found to affect length of storage of various items were type of freezing storage unit in all cases and location of residence in all cases except potato products and dinners. The number of persons in a household appeared to have no effect on length of storage.

Sixty-five percent of the families stored most of their frozen food purchases in either a combination refrigerator-freezer or a separate food freezer. Households in which only a conventional refrigerator was available held purchased frozen items for the shortest periods of time (generally no longer than 2 weeks). Those with separate freezers tended to be more variable than others in the length of storage periods reported.

Families in rural areas generally stored most items for longer periods than the other two population groups. The fact that 63 percent of the rural households were equipped with freezers in comparison to 25 percent of those in cities and 31 percent in towns was probably related to this finding.

Freezing storage unit temperatures measured in 222 homes ranged from — 11° to 30° F. In conventional refrigerators, ranges of — 5° to 30° F. were found, with a median of 15° F. Freezer temperatures ranged from — 11° to 10° F., with a median of 0° F. In combination refrigerator-freezers, the lowest temperature recorded was — 10° F. and the highest, 25° F. The median for this type of freezing storage unit was 4° F.

In about 10 percent of the households, frozen foods were held at temperatures above 20° F. In most such cases, however, storage was not longer than 1 week. In nearly one-fourth of the cases, temperatures were between 11° and 20° F.

In the responses concerning both length of storage of commercially frozen food and other handling practices, a general awareness of the special handling requirements of frozen food was indicated.

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