

CERTAIN FACTORS AFFECTING THE PALATABILITY  
OF PRECOOKED FROZEN BRAISED STEAKS

by

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## INTRODUCTION

Precooked frozen foods were developed experimentally as early as 1935. Some of these foods which found their way to the markets were not always entirely successful. In the last five years precooked frozen foods have improved in quality and consumer acceptability. Williams (1945) pointed out that from 1942 to 1943 cooked frozen food production jumped from one-half million pounds to seven million pounds. In 1944 there was a decrease in the number of foods which had been popular in 1942 and 1943, possibly because these products had failed to measure up to satisfactory standards of quality.

There are certain factors which have been responsible for poor quality precooked frozen foods. Some of the major factors have been poor packaging, incorrect reheating methods and low quality at a price considerably out of line. This does not mean that no precooked items of merit have been produced, or that there is no future in this type of frozen food. However, since one of the main reasons for freezing cooked or prepared foods is to have them ready or almost ready to serve when needed, it is necessary that research be done to find desirable and acceptable methods for handling such foods. Some of the food processors in the past have been in such a great rush to get their products marketed that they have been reluctant to rely on research to test and approve methods for handling this type of frozen food.

Consequently, many undesirable products have reached the market only to be rejected by the consumer.

Food acceptability has come to be recognized by present day nutritionists as a new science, valuable in finding which foods people like and why. Therefore, one of the most logical methods to use in finding acceptable foods would be to have the food judged by a reliable palatability or taste panel.

Since research on precooked foods is still inadequate, there exists an uncertainty regarding the quality of precooked meats as compared with the freshly cooked ones. The precooked foods most likely to become popular with the housewife will be a variety of "quality main dishes" including meats, which after reheating will provide the main course of the meal, thus eliminating cooking and kitchen mess. At the right price there is no reason why these dishes should not have wide appeal, although acceptance may take several years. This type of precooked frozen food will have to go through the mill of consumer acceptance which will eventually separate the desirable products from the undesirable.

The purpose of this study was to determine the effects of: various lengths of storage at three different storage temperatures; various types of packaging materials; and methods of reheating upon the palatability of precooked frozen braised steaks as compared with similar scores of the same steaks when freshly cooked.

## REVIEW OF LITERATURE

There has been some research done in the last few years regarding the lengths of storage and ideal storage temperatures for precooked frozen meats in general. Hutchings and Evers (1946) stated that much of the experimental work done on any of the phases of precooked frozen foods has been based on storage tests of from two to four months at temperatures so low that they would not be commercially practicable. Fenton and Darfler (1946) did considerable research with this type of frozen food, and they concluded that the maximum storage life for roasted meats was from three to eight months. They also stated that if meat or poultry was stored for more than six to nine months, particularly if not well wrapped, it would become dry and powdery in texture. These same workers, as well as many others, found that the more rapidly the food was frozen the less would be the breakdown in plant and animal tissue and the better the quality. They recommended that the highest temperature for storing all uncooked food was 0° F. and that at lower temperatures the storage life would be longer. Since cooked foods are more susceptible to bacterial contamination than the uncooked ones, it would appear that neither should they be stored at temperatures above 0° F.

Tressler and Evers (1947) gave as advisable temperatures for freezing uncooked meat -10° to -30° F. and as temper-

atures for storage 0° to -10° F. Winter and Hustrulid (1944) recommended a storage temperature not higher than 0° F. for frozen foods. They also stated that there was little advantage in a storage temperature lower than -5° F. and that fluctuating storage temperatures were not necessarily harmful provided the temperature did not rise above 0° F., but that it was desirable to control the temperature within a range of ±5°. Woodroof (1946) found that the higher the storage temperature of the frozen food the more rapid was the deterioration in flavor. In a study by Kniskern (1947), it was demonstrated that the storage life for precooked beef was 10 months and for precooked pork five months when stored at 0° F. Hankins and Hiner (1940) did a study of the effects of freezing on the tenderness of beef. They found that freezing effected a definite tendering of meat and postulated that the tendering might be caused both by mechanical action of freezing and enzyme action.

Research workers who have done considerable experimenting with precooked frozen foods have realized that when the food retained its good quality it had been properly packed and packaged. The prime purpose of food packaging materials as given by Adams (1947) was to protect the contents from the air and from loss of moisture while in the dry atmosphere of the freezer. With this in mind, it was easily understood that the materials must be moisture-vapor-proof. Adams also made the statement that a material which was waterproof was not necessarily vapor-proof. Good packaging materials, she postulated, should also be free from odors or flavors, be grease-proof, be easy to

handle, to seal and to label, and should resist breaking and splitting when subjected to the lower temperatures. Ziembra (1947) stated that new uses were being made of plastic films and coatings for packaging frozen foods. The materials which he found to be most satisfactory included: polyethylene and pure or mixed polymers or copolymers of vinyl chloride, vinyl acetate or vinylidene chloride. The pliofilm sack which is heat sealable, air and water tight and break proof under normal handling conditions was also recommended by this worker as a desirable type of packaging material. Winter (1946) tested 22 different packaging materials to note the moisture loss. He found that all materials containing paper stock increased in weight during a 12-week storage period at 0° F. The materials in which there was not a significant change in weight included: aluminum foil and acetate, transparent plastic bags, pliofilm, FF120 gauge, and 300 MSAT cellophane. He also proved that tightly wrapped packages exhibited less loose frost inside the bag than those loosely wrapped. Fenton and Darfler (1946) found in their experiments that suitable packaging materials for freezing cooked foods included the following: cylindrical waxed containers, moisture-proof bags, moisture-proof cellophane, pliofilm, rubber latex bags and metal foil. They also concluded that the only containers available which were completely water-vapor-proof were the glass jars and tin containers. Hutchings and Evers (1946) pointed out from their work that packaging problems facing production men today were very

acute. They said this was especially true in the packaging of precooked meat dishes since these fatty foods demanded special grease-proof containers as well as containers which were moisture-vapor resistant.

McCoy and co-workers (1947) made a study of the effect of various wrapping materials upon the quality of the frozen product. They recommended that laboratory moisture-vapor transmission values at 100° F. and 90 percent relative humidity were not a reliable index of the suitability of materials for wrapping frozen foods. These same workers advocated that more work be done at 0° F. While they made no attempt to study the relative cost of various materials, they were convinced that this was of minor importance when the difference of one cent to wrap a one dollar steak represented the difference between a good and an inferior, if not completely inedible product. They also emphasized the importance of the material being tightly applied to the surface of the product to exclude as much air as possible stating that a good material must be flexible enough to accomplish this feat. Griswold and Blakeslee (1939) made a study of the effect of different wrappings, temperatures, and lengths of storage on the keeping qualities of frozen pork chops. They used six types of wrappings which included: Kraft wrapping paper, whale hide, Thermo M, lard, lard and tallow and cellophane. They found that the wrapping material had little effect on the palatability of the chops, but had a decided effect on the moisture loss. Kraft wrapping paper



permitted the greatest loss, while cellophane allowed less moisture to escape than any of the other materials. Kniskern (1947) found that precooked beef roasts sliced and packaged deteriorated more rapidly in flavor than when they were packaged unsliced.

Very little has been reported in the literature on the use of various methods of reheating frozen cooked foods. Jeffrey (1942) concluded from her study that when meat was thawed for 48 hours at refrigerator temperature, there was a slightly larger amount of press fluid than when it was thawed at room temperature or at 350° F. oven temperature. She also found that the percentage cooking losses by each method of thawing varied only slightly.

Fitzgerald (1947) emphasized the necessity in speed in the handling of precooked frozen foods at every stage in their preparation. He said that the time the product was allowed to remain within the incubation range of 130° F. down to 50° F. should be reduced to absolute minimum. He suggested that food packed hot be cooled rapidly by placing the hot packages immediately into the freezer. Covering the meat with a sauce or gravy was also found to prevent oxidative rancidity since it protected the fat from direct contact with the air. Fenton and Darfler (1946) concluded from their experiments that frozen cooked foods should be prepared for the table as rapidly as possible to prevent loss of high quality in flavor and nutrients. One of the reasons these workers gave for freezing cooked foods was to have them almost ready to serve when needed.

They further stated that too much time between the freezer and table would defeat this objective.

Lowe and McClurg (1946) reported the results of their work on different methods of defrosting and cooking and how these affected the palatability of the meat. They found that the length of time that cooked beef was thawed after being taken from the locker made very little difference in the taste of it. The rate of thawing by refrigerator was longer than by any of the following methods used: cooking meat while still frozen; thawing at room temperature; and thawing in water.

Stellberg (1943) found that it was unnecessary to thaw meat completely before cooking, but if thawed at least two-thirds previous to cooking, it would cook more uniformly.

Wilmeth (1945) found that meat reheated in the double boiler had smaller losses than when reheated in the oven at 350° F. She concluded that the time of reheating was so long that it made the use of precooked pork chops and beef steaks questionable. Kniskern (1947) made a study of certain factors upon characteristics of stored precooked frozen beef and pork. She demonstrated that reheating by the infrared method was twice as fast as the double boiler method. However, since reheating by infrared required as much time as the initial cooking, she concluded there was no advantage in precooking steaks from the standpoint of saving time. The infrared oven was built and designed by this worker and others and would not be available to the average housewife. The study showed that beef

steaks and roasts as well as pork chops and roasts could be satisfactorily reheated by either the infrared or double boiler method to produce acceptable products. The reheated products, according to her study, were never on par with the freshly cooked meats.

This recent literature brings out the fact that precooked frozen foods can be acceptable if some of the limiting factors detracting from their quality can be solved.

#### EXPERIMENTAL PROCEDURE

The steaks used in this study were cut from Grade A beef rounds. The rounds were purchased from John Morrell and Company, a meat packing plant in Topeka, Kansas. Paired steaks were cut one inch in thickness by the butcher, under supervision, at the local locker plant. The steaks were labeled, right and left, and numbered to facilitate ease and accuracy of identity. They were double wrapped in locker paper, quick frozen, and stored at  $-10^{\circ}$  F. until ready for cooking. The study followed two lines of investigation.

Eight pairs of the steaks from two animals were used in the first phase of the study. These steaks were cut and placed in storage in the fall of 1946. They were removed from the locker, one pair at a time, 40 hours prior to cooking and were defrosted in the refrigerator at a temperature of approximately  $40^{\circ}$  F. After defrosting the meat was unwrapped and each steak was

weighed on a torsion balance. Suet was cut from the steak and placed in a preheated iron skillet and heated for two minutes. In the meantime, 18 grams of flour and 13 grams of salt were mixed and pounded into each steak. A meat scorer was used for pounding each side a total of 50 strokes. Next the meat was placed in the hot skillet and seared one and one-half minutes on each side. At the end of the searing time 60 milliliters of distilled water were added and the meat with its sauce was removed to a weighed four-quart earthenware casserole. The meat and sauce were weighed, then placed in an electric oven which had been preheated to 350° F. and cooked for one hour. The braised meat and sauce were removed from the oven and weighed again. The bone and gristle were removed from the meat prior to packaging. The weight of the meat to be packaged was then determined. A portion from the lean and fat of each steak was scored immediately after cooking by a palatability committee, consisting of five members of the Department of Food Economics and Nutrition. A grading chart for cooked meat, compiled by the Committee on Preparation Factors, National Live Stock and Meat Board, was used for the judging scores. The samples were all numbered and each judge received the same section as nearly as possible each time.

Next, each steak was divided into three approximately equal portions for packaging. Two servings, separated by a layer of cellophane paper, were placed in each package. About one-third of the sauce was added to each. The total weight of

each package averaged approximately 375 grams. All weight determinations were made according to Form 1.

The meat was packaged in a moisture-vapor-proof MSAT-83 cellophane bag and enclosed in a waxed cardboard carton. A waxed paper cardboard funnel was used in filling the bags to avoid splattering grease on the sides of the bag and interfering with the seal. Before sealing the packages, excess air was worked out of the bag. A heated curling iron was used in sealing the bag, sealing it as closely to the meat as possible. The packages were labeled with the date, cut of meat, steak and pair number, weight of contents, and temperature for storage. All the packages were placed in a commercial home freezer at  $-10^{\circ}$  F. immediately after sealing. They were left in the freezer approximately 24 hours and then removed to the storage locker. One package from each steak was stored at  $10^{\circ}$  F., another at  $0^{\circ}$  F., and a third at  $-10^{\circ}$  F. These were removed after storage periods of 70, 84, 126, 149, 161, 175, 189, and 203 days, respectively.

When they were taken from storage, they were placed overnight in a commercial home freezer at  $0^{\circ}$  F. prior to reheating. The hard frozen meat, sauce and cellophane bag were weighed and calculations made of changes in weight, Form 1.

The reheating method used consisted of putting the cellophane bag and frozen meat in a double thickness of moistened 45 pound vegetable parchment paper and tying it securely. Then it was dropped into a tightly covered kettle containing one

liter of boiling water and heated for 30 minutes. At the end of the heating period the cellophane bag containing the reheated contents was put in a heated weighed casserole and weight determinations made, Form 1.

Samples of the fat and lean from each package of the reheated meat were scored by the palatability committee. Comparisons were made of the scores of the freshly cooked meat with meat after storage and reheating, Table 1.

In the second phase of the study, 16 pairs of round steaks were cut from two animals in a manner identical to those in the preceding phase. These steaks were numbered one to 16, right and left. Up to the time of packaging they were treated identically as those in the first phase of the experiment with the following exceptions: the amount of seasonings used was determined by allowing one gram of flour per 64 grams of meat and one gram of salt per 88 grams of meat; a pyrex casserole was used for braising instead of the earthenware one; and the bone and gristle were removed from the thawed meat before cooking.

After cooking, each steak was divided in five portions and packaged in five different types of frozen food bags. These bags were selected from samples obtained from approximately 20 different commercial companies manufacturing frozen food containers. The five bags were lettered A, B, C, D, and E for ease in identification. Bag "A" was a moisture-vapor-proof MSAT-83 cellophane bag, bag "B" a Lok-Seal 140FF pliofilm material, bag "C" a bleached kraft base stock paper coated on the inside with

a heat sealing moisture proof composition, bag "D" a bleached kraft base stock paper laminated to a heat sealing cellophane, and bag "E" was made from a 40 pound white kraft paper lined with 140 P 6 pliofilm. The bags were all heat sealable. Approximately 250 grams of meat and 50 grams of sauce were packed in each package. All weights of the meat and sauce were recorded in the same manner as in the first phase. The bags were heat sealed, labeled and dated, then placed immediately in a commercial home freezer at  $-10^{\circ}$  F. and left for approximately 24 hours. They were all removed from the commercial home freezer to a storage locker where they were stored at  $0^{\circ}$  F. until the time of reheating.

Only the steaks packaged from the left side of the animal were used for reheating. Those from the right side were left for longer storage and future research. The packages were removed for reheating after a storage period of approximately 14 days since the storage was not a factor in this phase of the study. Weights were taken of the frozen meat and sauce as in the preceding phase, Form 1.

Four methods of reheating were used. These were designated by numbering I, II, III, and IV for ease of identity. Method I was the oven-casserole method in which the frozen meat and sauce were removed from each bag and placed in a pint-sized earthenware casserole and weighed. The casseroles were covered and placed in a preheated electric oven at  $350^{\circ}$  F. for 50 minutes. The casseroles were numbered each time and placed in the

same position in the oven.

Reheating Method II was the double boiler method. The frozen meat and sauce were placed in the weighed top of a pyrex double boiler and weighed. In the meantime, 960 grams of water were placed in the lower part of the double boiler and heated to boiling. The top of the double boiler containing the frozen meat was placed over the boiling water and contents heated a total of 60 minutes. At the end of the first 30 minutes the meat was broken apart and turned to facilitate reheating.

Method III was the pressure saucepan method. A four-quart Mirro-Matic pressure saucepan was used. The rack was placed in the pan and 720 grams of water were added. The frozen meat and sauce were removed from the bags and placed for reheating in small tin cake pans measuring  $4 \frac{1}{4} \times 4 \frac{1}{4} \times 1 \frac{3}{4}$  inches. The meat and sauce were weighed in the cake pan and all reheated in the pressure saucepan. The lid of the saucepan was securely fastened and the pan placed on the stove on high heat. When steam began to escape from the petcock, the time was noted and the flame turned to medium. The meat and sauce were steamed 20 minutes without the use of the pressure gauge.

Method IV was the direct heat-skillet method. The hard frozen meat and sauce were placed in a tightly covered eight-inch aluminum skillet and weighed. Next they were placed over a burner turned on high heat. After heating two minutes, the meat was turned over and heated an additional four minutes. The meat was then broken apart to facilitate the reheating and



simmered for 14 minutes longer. The heating time by this method was a total of 20 minutes.

Steaks numbered 1L, 5L, 9L, and 13L were reheated by Method I; those numbered 2L, 6L, 10L, and 14L by Method II; 3L, 7L, 11L, and 15L by Method III; and steaks 4L, 8L, 12L, and 16L by Method IV.

After reheating by each method, weights were taken and calculations made of the changes and percentage changes in weight according to Form 1. The steaks were all scored by the palatability committee and comparisons made of the palatability data and other factors of the fresh-cooked and precooked-frozen meat as affected by the five packaging materials and four reheating methods (Tables 2 and 3) respectively. Each time a bag was opened after freezing, it was examined carefully and notes made of the condition of both the bag and the seal.

## RESULTS

The data accumulated in the experimental procedure were assembled and averages and comparisons made. The results of the effects of storage time and temperature, packaging materials, and reheating methods are presented in tabular form accompanied by an explanation and discussion.

The data in Table 1 give the average palatability scores for the first eight pairs of precooked frozen steaks which had

Table 1. Summary of palatability data for precooked-frozen braised steaks stored at three different temperatures for various lengths of time and for the fresh-cooked.

Pair no.	Days stored	Palatability data																								
		Desirability												Tenderness				Juiciness								
		Aroma				Fat				Lean				Quality				Quantity								
		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		Stored at		
		10°F.	0°F.	-10°F.	Fresh	10°F.	0°F.	-10°F.	Fresh	10°F.	0°F.	-10°F.	Fresh	10°F.	0°F.	-10°F.	Fresh	10°F.	0°F.	-10°F.	Fresh	10°F.	0°F.	-10°F.	Fresh	
4	203	5.4	5.2	5.3	6.0	3.8	4.2	4.4	5.9	5.0	5.3	5.4	5.3	5.9	5.6	5.3	4.4	4.9	4.7	4.8	4.6	4.9	4.5	4.4	4.9	
5	189	5.7	5.5	5.1	5.6	4.7	4.2	4.3	5.7	5.3	4.9	4.7	6.0	4.4	5.2	5.0	3.8	4.8	5.0	4.7	4.3	4.2	4.4	4.5	4.3	
6	175	4.7	4.9	5.0	5.7	3.3	3.7	3.3	5.5	4.3	4.8	4.8	5.9	5.1	4.4	4.1	4.6	4.9	4.7	4.7	4.5	4.5	3.9	4.2	4.5	
7	161	5.7	5.6	5.8	5.9	3.8	4.6	4.7	5.7	5.4	5.6	5.7	6.2	4.4	4.2	4.1	4.6	4.8	4.8	4.7	4.9	4.5	4.4	4.2	4.6	
8	149	5.7	5.9	5.8	5.9	5.5	4.7	5.3	5.8	5.8	5.9	5.7	5.9	4.3	4.4	4.9	4.7	5.4	5.3	5.1	4.6	4.7	5.1	4.9	4.7	
9	126	5.9	5.7	5.5	5.8	4.2	4.5	4.2	5.5	5.4	5.2	5.2	6.3	5.1	4.8	4.5	5.6	5.2	5.0	5.0	5.1	4.9	4.8	5.1	4.9	
10	84	5.7	5.5	5.8	6.3	4.9	4.9	4.7	5.6	5.4	5.8	5.8	6.1	5.3	5.0	5.7	4.3	5.4	5.3	5.2	4.9	5.6	5.3	5.3	5.3	
11	70	6.0	5.7	6.1	5.8	5.5	4.6	5.9	5.4	5.7	6.0	5.7	5.9	5.2	5.4	5.5	5.1	5.2	5.3	5.2	5.2	5.1	5.4	5.1	5.3	
Average		5.6	5.5	5.6	5.9	4.5	4.4	4.6	5.6	5.3	5.4	5.4	6.0	5.0	4.9	4.9	4.6	5.1	5.0	4.9	4.8	4.8	4.7	4.7	4.8	

been stored at three different temperatures from 70 to 203 days respectively. These scores were compared with the freshly cooked steaks. In aroma, 80 percent of the precooked frozen steaks stored at the three different temperatures ranked lower in desirability than when freshly cooked. The length of the storage period did not reveal any significant differences in this respect. The average palatability scores of the steaks at 10° F. and -10° F. was slightly above those stored at 0° F., but in all cases the average score of the freshly cooked steaks ranked higher than any of the precooked ones when stored at any of the three temperatures. After 203 days of storage, the precooked steaks ranked considerably lower in desirability of fat. These same steaks scored higher when stored at -10° F. than when stored at 0° F. or 10° F. The average score in desirability of flavor of fat indicated definitely that the fat declined in flavor after precooking, freezing, and storing. The average of those stored at -10° F. was slightly higher than those stored at 0° F. or 10° F. Up to 149 days of storage the fat flavor appeared to be quite acceptable, but from then on it became less desirable. The flavor of the lean became less desirable as storage time progressed, but not to such a degree that it was inedible or unacceptable. After 203 days of storage the lean stored at -10° F. was more desirable than that stored at 10° F. or 0° F. In average palatability scores the flavor of the freshly cooked lean scored 6.0 as compared to a score of 5.4 for that stored at -10° F. and 0° F. That stored

at 10° F. rated the slightly lower score of 5.3. The fresh cooked meat scored higher in desirability of lean than the precooked frozen meat in 30 out of 32 samples.

In 75 percent of the average scores the precooked frozen meat scored somewhat higher in tenderness than the freshly cooked. After 203 days of storage, all three samples of the precooked frozen meat scored higher in tenderness than the same meat when fresh-cooked as shown by Table 1. After 175 days of storage all of the precooked meat scored higher in tenderness than the freshly cooked.

The data on the quality of juiciness of the meat revealed a higher average score for the precooked meat when compared with the freshly cooked. After 161 days of storage all of the precooked meat rated a slightly higher score than the freshly cooked. The average score of the meat stored at 10° F. was better than that stored at 0° F., and the meat stored at 0° F. scored somewhat higher than that stored at -10° F. The average scores on the quantity of the juice were practically the same for the three samples of precooked and the freshly cooked. The meat stored at 10° F. had a slightly higher rating than either of the samples stored at 0° F. or -10° F. Length of storage did not reveal any great differences in the quantity of juice.

In Table 2 a summary is given of the palatability data and of the other factors for fresh-cooked and precooked-frozen steak as affected by five types of packaging materials. The total score for the fresh cooked is higher than the total score for

Table 2. Summary of palatability data and other factors for precooked-frozen braised steaks as affected by five types of packaging materials and for the fresh-cooked.

Palatability data	Precooked-frozen samples					Fresh-cooked samples
	Types of packaging materials					
	A <sup>1</sup>	B <sup>2</sup>	C <sup>3</sup>	D <sup>4</sup>	E <sup>5</sup>	
Desirability of:						
aroma	6.2	6.2	6.1	6.1	6.0	6.4
fat	5.3	5.2	5.0	5.1	4.9	6.1
lean	6.0	6.0	5.8	5.9	5.9	6.3
Tenderness	5.4	5.3	5.2	5.3	5.2	5.3
Juiciness:						
quality	5.3	5.3	5.3	5.2	5.2	5.2
quantity	4.6	4.8	4.7	4.6	4.7	4.9
Total score	32.8	32.8	32.1	32.2	31.9	34.2
Other factors:						
gain in wt. (gms)	0.125	0.25	0.75	0.81	0.56	-
percentage change in wt.	0.02	0.07	0.23	0.25	0.17	-
condition of seal after freezing	very good	excellent	fair	fair	excellent	-
condition of bag after freezing	soft	very tough	coating came off on meat	lining split and stuck to meat	not always filled to corners	-

<sup>1</sup>Cellophane MSAT-83

<sup>2</sup>Pliofilm Lok-Seal 140FF

<sup>3</sup>Coated with moisture-proof composition kraft paper bag

<sup>4</sup>Kraft paper bag laminated to cellophane

<sup>5</sup>Kraft paper bag lined with pliofilm

any of the precooked meat. Each of the meat samples packaged in cellophane or pliofilm scored 32.8 points, respectively, as compared to 32.1 for the kraft paper bag coated with the moisture proof composition, 32.2 for the kraft paper bag laminated to cellophane and 31.9 for the kraft paper bag lined with pliofilm. All the bags containing paper stock scored lower than the cellophane and pliofilm in palatability. The desirability in flavor of fat seemed to be most affected by the type of bag used. It was interesting to note that the bags giving the best scores in this respect ranked in the same order of preference as they did in total scores. None of the packaging materials imparted undesirable aroma or off-flavor in the lean of the meat. The quality of the juice of the precooked meat rated as high or higher than for the freshly cooked.

All of the precooked-frozen meat gained slightly in weight after two weeks of storage. The packaging materials containing paper stock were found to increase more in weight than either the cellophane or pliofilm bags. Cellophane gained the least weight and pliofilm rated second in this respect. The bag made of kraft paper and lined with pliofilm gained less in weight than either of the other two kraft paper bags. The pliofilm bag (B) and the bag lined with pliofilm (E) sealed excellently in the majority of cases. The bag coated with the heat sealing material (C) and the one laminated to cellophane (D) gave only fair seals. The coatings of these bags adhered to the meat after freezing. The cellophane bag was soft after freezing and

tore easily, while the pliofilm bag was very tough and difficult to open.

The summary of palatability data and other factors for fresh-cooked and precooked-frozen braised steaks as affected by four reheating methods is shown in Table 3. The total palatability score for the reheating ranks from 32.8 down to 31.7 points with only a variation of a total of 1.1 points. However, in every case the freshly cooked meat scored higher than the meat when precooked, frozen and reheated. The meat reheated by oven-casserole (Method I), double boiler (Method II) and direct heat-skillet (Method IV) scored somewhat higher in tenderness than it did when first cooked. All of the precooked samples ranked lower or the same in desirability of aroma, flavor of fat and lean when compared to the fresh-cooked. The reheating method seemed to make very little difference in this respect. The meat reheated by direct heat-skillet (Method IV) decreased more in quantity of juice than the meat reheated by the other three methods. All of the meat lost in weight when reheated by oven-casserole (Method I), double boiler (Method II) and direct heat-skillet (Method IV), while the meat reheated by pressure saucepan (Method III) increased in weight. There was less loss in weight when the meat was reheated by the double boiler method. Twice as much weight was lost when reheated in the oven as compared with the double boiler. The meat reheated in the pressure saucepan gained an average of 27.2 grams in weight while that reheated in the skillet over direct heat lost an

Table 3. Summary of palatability data and other factors for precooked-frozen braised steaks as affected by four reheating methods and for the fresh-cooked.

Palatability data	Methods of reheating							
	I <sup>1</sup>	Fresh	II <sup>2</sup>	Fresh	III <sup>3</sup>	Fresh	IV <sup>4</sup>	Fresh
Desirability of:								
aroma	6.1	6.5	5.9	6.5	6.2	6.2	6.1	6.3
fat	5.2	6.0	5.0	6.2	5.0	6.0	5.2	5.9
lean	5.8	6.2	5.8	6.1	6.1	6.3	5.9	6.1
Tenderness	5.3	4.9	5.1	4.9	5.2	6.0	5.3	5.2
Juiciness:								
quality	5.2	5.0	5.2	4.9	5.4	5.3	5.1	5.3
quantity	4.9	4.9	4.7	4.6	4.9	5.2	4.4	5.0
Total score	32.5	33.5	31.7	33.2	32.8	35.0	32.0	33.8
Other factors:								
change in wt. (gms)	-5.4	-	-2.2	-	+27.2	-	-34.2	-
percentage change in wt.	-1.55	-	-0.62	-	+ 8.69	-	-11.4	-

- <sup>1</sup>Oven casserole  
<sup>2</sup>Double boiler  
<sup>3</sup>Pressure saucepan  
<sup>4</sup>Direct heat skillet



average of 34.2 grams in weight.

## DISCUSSION OF RESULTS

From the data concerning storage temperatures and lengths of storage, it seemed apparent that the precooked-frozen steaks were less desirable from the standpoint of palatability than the freshly cooked ones. This finding was in accord with Kniskern (1947) and Wilmeth (1945) who noted that reheated precooked steaks were less desirable. The steaks stored as long as 203 days appeared to be acceptable in palatability with the exception of the flavor of fat. This finding would therefore appear to be in agreement with Fenton and Darfler (1946) who gave as the storage life for roasted meats three to eight months provided the meat was well wrapped. In desirability of aroma, flavor of fat and flavor of lean the meat stored at  $-10^{\circ}$  F. scored slightly higher than that stored at  $10^{\circ}$  F. or  $0^{\circ}$  F., however, the meat stored at  $10^{\circ}$  F. ranked higher than the meat stored at  $0^{\circ}$  F. This might be explained by the fact that the locker at  $0^{\circ}$  F. was remodeled and the temperature on several days went as high as  $10^{\circ}$  F. This fluctuating temperature, according to Winter and Hustrulid (1944), is harmful when it varies more than  $\pm 5^{\circ}$ . The meat stored at  $-10^{\circ}$  F. was moved while the locker plant was undergoing construction, but it was not known whether the temperature fluctuated greatly or not. These changes, which were difficult to control, might par-

tially account for the results obtained in regard to the effects of the three storage temperatures upon the palatability of the meat. Since this meat was packaged in small servings, there were more chances for oxidation and surface exposure than if it had been packaged in larger pieces. According to Kniskern (1947) the meat packaged unsliced was better than if it were sliced and then packaged, which might explain why this meat had begun to deteriorate in flavor after 203 days of storage. The precooked meat became more tender after reheating than the freshly cooked meat because of the freezing and additional cooking during reheating. This is confirmed by the study of Hankins and Hiner (1940) in which they found that tendering of beef increased after freezing. For this reason, foods for freezing should not be over-cooked or they will become mushy and undesirable after reheating. While reheating was not a factor in this phase of the experiment, it might be mentioned that the method used was time consuming both from the standpoint of the time to reheat and the time required to wrap the meat in parchment prior to the reheating.

The results of the effects of various wrapping materials indicated that cellophane (A) and pliofilm (B) are the two most acceptable both from the standpoint of maintaining desirability in flavor and preventing changes in weight. It was also revealed that packaging materials containing base stock paper increased more in weight than either the cellophane (A) or pliofilm (B). Both of these findings are in accord with the work

done by Winter (1946). The data would indicate that cellophane (Bag A) and pliofilm (Bag B) are more water-vapor-proof than the others (Bags C, D and E) which have base stock paper as a base material. This is also confirmed by the findings of Winter (1946). The lined paper bags (Bags C, D and E) also took up more space in the package. They were less pliable and more difficult to bring into close contact with the meat, thus making it difficult to eliminate excess air. This fact explains in part why the meat declined in palatability ratings because there would be more chance for oxidation to occur. None of the packaging materials imparted off-flavor or odor to the meat, even though the lining in bags C and D did adhere to the meat after freezing.

Results of the effects of reheating methods upon palatability of the meat indicated that all of the methods were acceptable. The meat reheated by the direct heat-skillet method had less juice than when reheated by the other three methods. It was interesting to note that the methods requiring the longest period of time also gave the least changes in weight. The meat reheated by steaming in the pressure saucepan gained considerably in weight due to the condensation of the steam. However, the sauce did not have a diluted flavor and the quality of the juice in the meat scored higher. The quantity of juice in the meat reheated by this method was lower than when freshly cooked, but the difference was not as great as when reheated by direct heat. All of the meat increased in tenderness after freezing and reheating except the meat reheated by the

pressure saucepan. The cause of this was difficult to explain.

Methods (III) pressure saucepan and (IV) direct heat-skillet each required 20 minutes which is less than the time required by the infrared method used by Kniskern (1947) The total scores would indicate that insofar as palatability is concerned, either of these methods would be acceptable.

The precooked-frozen braised steaks were acceptable after storage periods up to 203 days stored at any of the three temperatures, 10° F., 0° F. and -10° F. as well as when packaged in five types of packaging materials and reheated by four different methods. However, the same steaks when freshly cooked rated higher in desirability in every instance. From the standpoint of the average homemaker, it would not seem advisable to precook and freeze steaks. Since they are acceptable and rate especially high after short periods of storage it might be time and labor saving for eating establishments where space is at a premium.

#### SUMMARY

This study was made to determine the effects of lengths of storage, temperatures of storage, packaging materials and reheating methods upon the palatability of precooked-frozen braised steaks. Other factors considered were changes in weight, percentage changes in weight and conditions of bags after sealing and freezing.

The meat was precooked by searing in its own fat, and after water had been added, braised in the oven for 60 minutes at 350° F. The meat was scored by a palatability committee immediately after cooking, and again after storage and reheating. Comparisons were made of these two scores and analyzed. The meat was packaged with sauce added.

In the first phase of the experiment eight pairs of steaks were used. MSAT-83 cellophane bags were used for packaging. These packages were stored at 10° F., 0° F. and -10° F. for periods ranging from 70 to 203 days. Each package was reheated for 30 minutes by first wrapping in parchment paper and then dropping into boiling water. Data were kept of all the weights before cooking, after freezing and after reheating, Form 1.

In the second phase of the experiment 16 pairs of steaks were braised in the same manner as in the first phase. Each steak was divided into five portions and packaged in five different types of packaging materials. These materials included (A) cellophane bag MSAT-83, (B) pliofilm bag FF140, (C) bleached kraft base paper stock bag coated with heat sealing material, (D) bleached kraft base paper stock bag laminated to cellophane and (E) 40 pound white kraft paper lined with 140 P 6 pliofilm. The meat was packaged in two serving portions separated by a piece of cellophane paper so that it might be broken apart to facilitate reheating. All the packages were stored at 0° F. Those numbered one L to 16 L were used for reheating. All the packages from the right side were left in storage for future

research. Palatability data were taken for these steaks the same as in the first phase.

Four methods of reheating were used in the second phase of the study and comparisons made. They included oven-casserole (Method I) at 350° F. for 50 minutes, double boiler (Method II) for 60 minutes, pressure saucepan-steaming without the use of the pressure gauge (Method III) for 20 minutes and direct heat-skillet (Method IV) for 20 minutes.

All of the reheated precooked-frozen meat scored less desirable in palatability than the same meat freshly cooked. Results from the first phase of the study revealed that the desirability in flavor of fat decreased more rapidly after storage than the flavor of the lean. The flavor of fat up to 149 days of storage was quite acceptable, but after that it became less and less desirable. Tenderness of the meat increased in score after cooking and freezing in 75 percent of the scores. After 161 days of storage all of the precooked-frozen meat rated slightly higher scores in quality of juice than the same meat freshly cooked. Length of storage revealed no great difference in quantity of juice when compared to the freshly cooked. The meat stored at -10° F. for 203 days rated slightly higher in desirability of fat than when stored at 10° F. and at 0° F. No significant difference was noted in the average scores when stored at the three different temperatures, possibly due to the fact that the lockers of -10° F. and 0° F. were being remodeled during the period of the study and temperatures fluctuated.

The data revealed that the cellophane bag (A) and pliofilm bag (B) were most desirable materials from the standpoint of palatability and moisture-vapor losses. These bags were also preferable because of ease in handling and good sealing qualities after freezing as well as before freezing.

The reheating in the double boiler (Method II) gave the least change in weight, but required the longest time (60 minutes). The pressure saucepan method (Method III) revealed a considerable increase in weight during reheating, but the flavor of the meat was desirable. From the standpoint of saving time, this method was more preferable than either the oven-casserole or the double boiler method. The direct heat-skillet method (Method IV) was also time saving, but resulted in a drier product. However, in total desirability score, it ranked on a par with the other three methods of reheating. Therefore, it was concluded that any of the reheating methods could be recommended as desirable since the differences in palatability scores were only slight.

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**APPENDIX**

## FORM 1 - Weight Determinations

## Before cooking:

- A. Wt. of casserole + raw defrosted meat
- B. Wt. of casserole
- C. Wt. of raw meat =  $A - B$

## After cooking:

- D. Wt. of casserole + seared meat + sauce
- E. Wt. of casserole + cooked meat + sauce
- F. Wt. of casserole + sauce
- G. Wt. cooked meat =  $E - F$
- H. Wt. of sauce =  $F - B$
- I. Total loss in weight =  $C - G$
- J. Percentage loss in wt. =  $I \div C$
- \* Bone and gristle removed

## Before freezing:

- K. Wt. of packaging materials
- L. Wt. of packaged meat + packaging materials
- M. Wt. of meat + sauce + packaging materials
- N. Wt. of meat + sauce =  $M - K$

## After freezing:

- O. Wt. frozen meat + sauce + packaging material
- P. Wt. frozen meat + sauce =  $O - K$
- Q. Change in wt. =  $N - P$
- R. Percentage change in wt. =  $Q \div N$

## After reheating:

- S. Wt. reheating container
- T. Wt. reheated meat + sauce + container
- U. Wt. sauce + container
- V. Wt. reheated meat =  $T - U$
- W. Wt. sauce =  $U - S$
- X. Wt. reheated meat + sauce =  $T - S$ .
- Y. Change in wt. after reheating =  $P - X$
- Z. Percentage change in wt. =  $Y \div P$

\*This was done before A in 2nd phase of experiment.

MEAT COOKING RECORD

Grading Chart for Cooked Meat

Cooking Laboratory No. \_\_\_\_\_ Sample No. \_\_\_\_\_ Kind \_\_\_\_\_ Date \_\_\_\_\_

FACTOR	PHASE	7	6	5	4	3	2	1	REMARKS
Aroma	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. per.	imper.	
	Desirability	very des.	des.	m. des.	s. des.	neutral	undes.	undes.	
Texture (Grain)	Intensity	very fine	fine	m. fine	s. coarse	coarse	coarse	coarse	
	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. per.	imper.	
Flavor of Fat	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. per.	imper.	
	Desirability	very des.	des.	m. des.	s. des.	neutral	undes.	undes.	
Flavor of Lean	Intensity	very pro.	pro.	m. pro.	s. pro.	per.	s. per.	imper.	
	Desirability	very des.	des.	m. des.	s. des.	neutral	undes.	undes.	
Tenderness	Intensity	very tender	tender	m. tender	s. tough	tough	very tough	ext. tough	
Juiciness	Quantity of juice	very juicy	juicy	m. juicy	s. dry	dry	very dry	ext. dry	
	Quality of juice	very rich	rich	m. rich	s. rich	per.	s. per.	imper.	

Color of Lean

Color of Fat

- 1. Light red
- 2. Dark pink
- 3. Light pink
- 4. Pinkish brown
- 5. Light brown
- 6. Dark brown

- 1. White
- 2. Creamy white
- 3. Grayish cream
- 4. Grayish white
- 5. Yellowish brown
- 6. Yellow
- 7. Amber

Key to Abbreviations

- pro. - pronounced
- m. - moderately
- s. - slightly
- imper. - imperceptible
- des. - desirable
- undes. - undesirable
- ext. - extremely
- per. - perceptible

Signature of Judge \_\_\_\_\_

MEAT COOKING RECORDS

Date \_\_\_\_\_

SUMMARY OF SCORES FROM GRADING CHARTS FOR COOKED MEAT

Cooking laboratory serial number \_\_\_\_\_  
 Animal number \_\_\_\_\_

Kind of meat \_\_\_\_\_  
 Cut of meat \_\_\_\_\_

Judges		INTENSITY						DESIRABILITY			
		Aroma	Texture	Flavor of fat	Flavor of lean	Tender- ness	Juciness		Aroma	Flavor of fat	Flavor of lean
Names	Symbols						Quality	Quantity			
<b>Total</b>											
<b>Average</b>											

Comments: