# TECHNICAL AND OPERATIONAL PROBLEMS OF SELF-SERVICE MEAT MERCHANDISING

Thesis for the Degree of M. S.

MICHIGAN STATE COLLEGE

Joseph Samuel Gowland

1949

# TECHNICAL AND OPERATIONAL PROBLEMS OF SELF-SERVICE MEAT MERCHANDISING

By

Joseph Samuel Gowland

A THESIS

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Animal Husbandry

1949

THESIS

ACKNOWLEDGMENT

The author wishes to express his sincere thanks to Mr. Lyman J. Bratzler, Associate Professor of Animal Husbandry for his guidance and suggestions, and to Mr. George T. Smith, President of the George T. Smith Market Baskets, Inc. and to his employees for their fine cooperation.

# TABLE OF CONTENTS

## INDEX TO FIGURES AND TABLES

# INTRODUCTION

The evolution of meat merchandising has been one of very slow growth. To trace the predecessors of our present retail meat merchant, the old time "butcher", we can go back to biblical history.

The practice of slaughtering has come down through the ages to our present day, and there are still thousands of farms where the crude methods of slaughtering for home consumption are practiced, and the excess meat sold to other consumers.

When the modern meat retailer is compared with the old time "butcher", it is evident that our present methods of meat retailing are really an evolution of the old time "butcher" and the so called butcher shop.

Webster defines a butcher as: "One whose business is to slaughter animals for market; also one who dresses and deals in meat for food."

To define our modern meat retailer as a "butcher" or his place of business as a butcher shop is a misnomer, as he does not perform the functions of a butcher (23).

Generally speaking, a change from the butcher to the retail meat merchant began to make headway about 1850. This change was brought about by a combination of factors: the

principal one being the rapid growth of the industrial East and expansion of villages to towns and of towns to cities. As towns and cities increased in size and population, the butcher who had a slaughter house, usually in the rear of his store, was forced for sanitary reasons to stop slaughtering within the city. Of necessity he was compelled to purchase his dressed meat from others ( 23).

With the advent of the retail meat dealer and the meat market, he found one of his major problems to be that of displaying the products he had for sale. During cold weather, quarters of beef were hung in the store windows or out on sidewalk stands, to show the type of merchandise handled.

When the quarters were hung in the meat market, the customer had little choice as to the kind of cut he would get. If he arrived when steaks were being cut, he would get a steak, when chucks were being cut he would get a chuck roast, in other words he would get the next cut that was exposed. It is easy to understand that the customer had a very limited selection with this type of merchandising.

With the development of health regulations, the unprotected hanging of meat was stopped and the retailer was required to protect his products from dirt and filth. This brought about the development of the meat counter or case. The first meat cases were very crude, they were enclosed on two sides with glass and usually had a stone or metal

bottom. Later the cases were entirely enclosed and refrigerated with ice.

After the development of the display case, the customer had a much wider choice; the quarters were broken down into smaller wholesale cuts, permitting a much larger selection of cuts from which to make a purchase. When the display cases were refrigerated, the meat merchandiser was able to break his wholesale cuts into steaks, roasts and many other cuts, and to display them for the customer to see and make his or her selection. During the 1920's mechanically refrigerated cases were manufactured and this development proved to be a great milestone in meat merchandising.

During the depression years of the 1930's the chain store organizations developed self-service merchandising. With this type operation the customer served herself instead of having a clerk serve the customer. This type of merchandising was first used for dry groceries that had a long shelf-life and few storage problems. Later it grew into the fruit and vegetable sections, and with the development and production of open refrigerated cases, into the dairy and cold meat departments.

Today the trend in all food merchandising has been toward the self-service type market. This type of merchandising has proven to be very popular with the customer. In many instances the savings resulting from

lowered overhead, labor savings, and mass merchandising have been passed on to the consumer in lowered prices. Recently numerous stores have adopted self-service meat counters (13).

The rapid expansion of self-service retailing of fresh meat since 1946 has aroused considerable interest in the food retailing industry and in marketing circles generally.

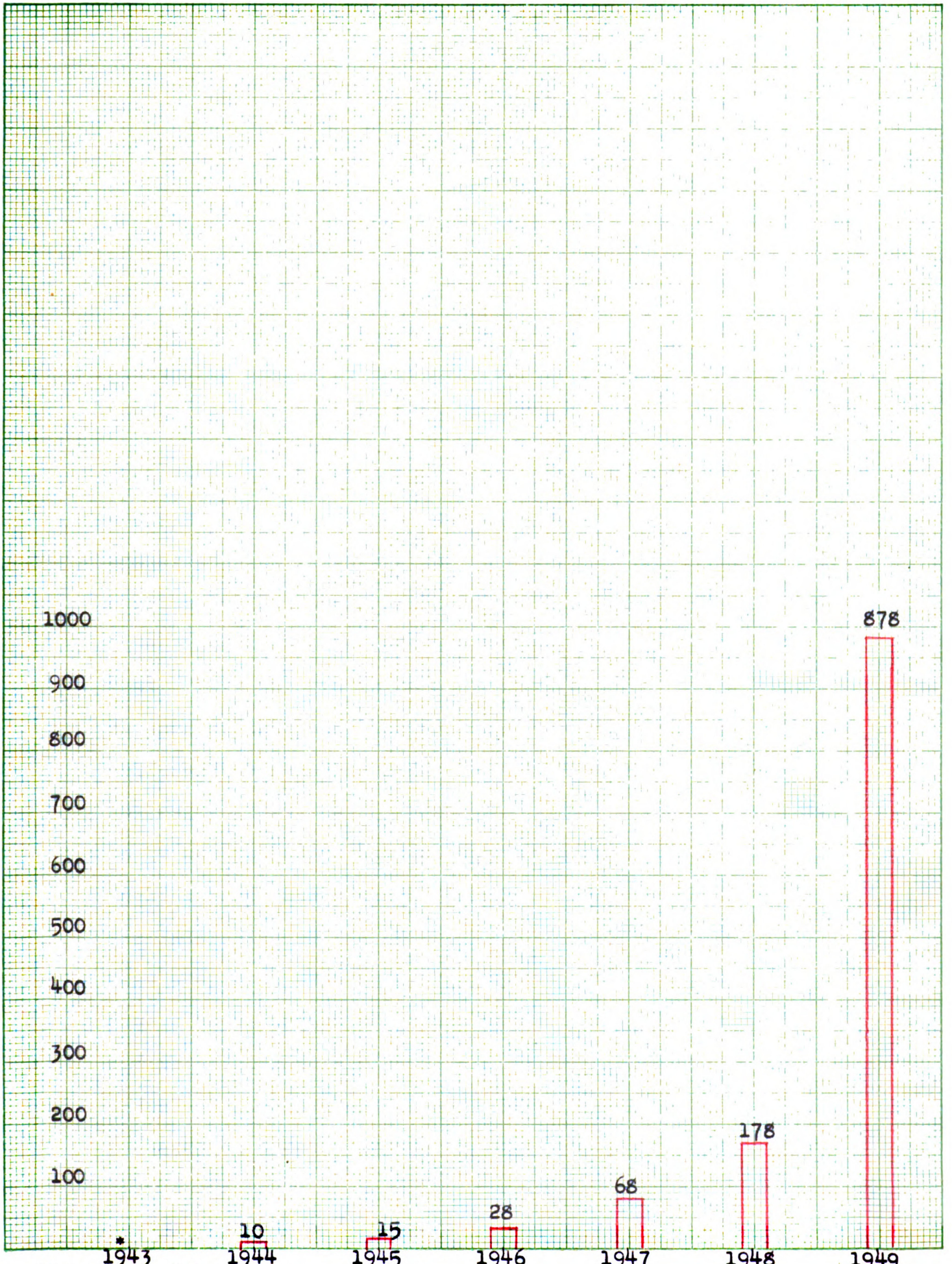
The origin of the sale of fresh meat by prepackaged self-service methods on a rather large commercial scale seems to have been located on the West Coast, centering around the Los Angeles area in 1942 (20). An unusually acute shortage of labor was the primary reason for this development in California (19).

All evidence points to the fact that prepackaged self-service meat merchandising is feasible. Its growth has been phenomenal (Figure 1). Between 1941 and 1943, there were less than 10 stores that provided 100 percent self-service meat merchandising. By 1944, there were 10; 1945, 15; 1946, 28; 1947, 68, 1948, 178; and by April 1, 1949 there were 878 stores in operation. (24) (31).

In discussing self-service meat, we should clearly differentiate between partial and 100 percent self-service. Stores on a partial self-service meat basis supplement their service meat department with one or more self-service

Number of Stores

Histogram Showing Rapid Growth of Self-Service Meat Stores as of April 1 each year.




*Less than 10 stores

cases. In 100 percent self-service, all meats are prepackaged and sold on a self-service basis. For the sake of brevity, we will hereafter refer to 100 percent stores as, "self-service stores."

This development, relatively speaking, is still in the pioneering stage, so that many of the problems, especially technical ones, have yet to be defined and studied.

With this in mind the author broke this problem into two separate, yet closely related sections. Part one was to be concerned with various wrapping materials and their relative serviceability, the primary interest being the differences in shrinkage or drip loss and the color preservation of the meat. Part two was to be a more or less practical approach to some of the retailing problems connected with prepackaged self-service meats in order to find some answers to the following questions: A. One of the most important problems to be controlled is that of extending the holding time or shelf-life of the prepackaged meat. Therefore; the author was interested in temperatures - the temperature of the meat when cut, when wrapped, and when put in the display case. The variation of temperatures in the display cases and the temperature of the packaged meat in the display cases. B. The problem of rewrapping broken and torn packages or those that are not acceptable to the consumer

due to an excess of drip or moisture collected in the package. C. The packages that were not sold and had to be remerchandised D. The percentage of customers purchasing meat, and the type and number of packages they purchased.

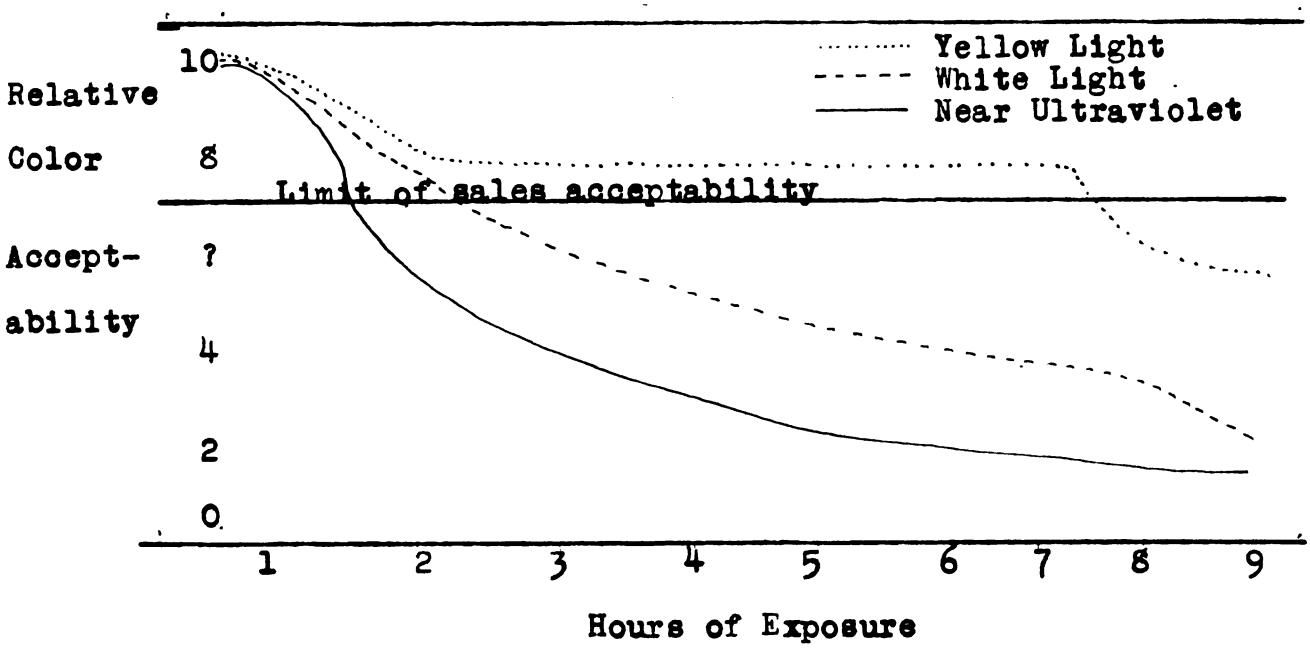
The first part of this study was done in The Michigan State College Meats Laboratory. The second part was carried out with the cooperation of a local chain store organization.

## REVIEW OF LITERATURE

In reviewing the literature on self-service meat, one is impressed with the newness and the rapid developments going on in this field. Prior to 1946, there were few references to self-service meats. During 1947, interest began to develop in this field, and in 1948 and 1949, there has been a large number of articles, reports and speeches on the subject of prepackaged self-service meats. However, most of these reports are of a popular vein and are of little or no use for our purpose.

One of the first studies made and reported was by Hockman (22) on the "Problems of Packing Meat Products". He divided the problem into several components; namely, color change, caring for drip loss, temperatures, and weight loss. The color situation was controlled to a certain extent by using Cellophane M.S.A.T.80 and using yellow, low intensity lights. There is great room for improvement in color preservation, but by using the above conditions meat prepackaging may be carried out quite successfully.

Figure 2 The Relation of Color Acceptability and Hours of Exposure to Light*



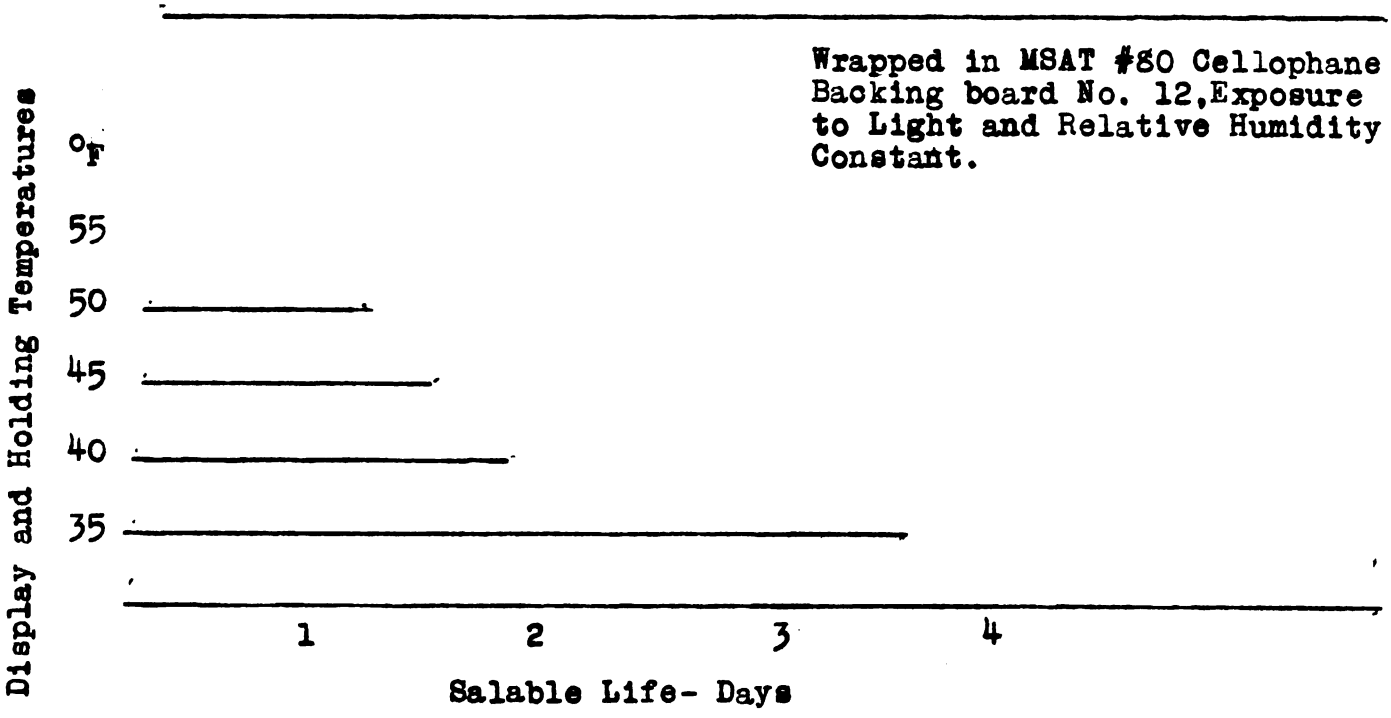

* (22)

When speaking of drip loss Hockman (22) says, "In order that fresh meat can be displayed and sold, provision must be made for removal of mechanical drip loss or weepage. Otherwise, under retail conditions we encounter an unsightly piece of meat with accumulated meat juices, wrapped in what originally might have resembled a transparent package. To help solve this problem, use is made of a backing board or tray in

which the board is incorporated as a part of the package. Boxboard manufacturers have been able to provide a special type of board which will not cause discoloration of the meat, will provide some absorbency so that mechanical weepage is absorbed, and will not disfigure the package externally."

Hockman, goes on to say, "The problem of proper refrigerated display fixture temperatures must be considered. Prepackaged meat has considerably more surface exposed than have wholesale cuts, and so care is required that proper temperature conditions are maintained. No real increase in salable life of packaged meats occurs until temperatures below 40° F are applied. A temperature of 35° F seems to give good sales life and is not a great deal more difficult to maintain than the higher temperatures."

Figure 3. The Effect of Temperature on the Salable Life of Loin Steaks*




* (22)

Hockman (22) made no mention as to the amount or percentage of drip he found present in the packages. However, he did report some results of shrinkage studies using Braunschweiger as the test meat. It may be of interest to note that he found that weight losses are affected to a great extent by temperatures. In this article he gave no results of

shrinkage with varying relative humidities. Figure 4 summarizes his weight loss data for a five day period.

Table 1 Effect of Time and Temperature on Weight Losses of Braunschweiger *

| Storage Temperature | Percent Weight Loss | | | | |
|---|---|---|---|---|---|
| | 24 hrs. | 48 hrs. | 72 hrs. | 96 hrs. | 120 hrs. |
| 36-40 | 0.46 | 0.97 | 1.54 | 1.96 | 2.86 |
| 40 | 0.92 | 1.38 | 1.89 | 2.27 | 2.65 |
| 45-52 | 0.99 | 2.10 | 3.26 | 4.44 | 6.09 |
| 50 | 0.99 | 1.57 | 2.20 | 2.65 | 3.80 |

* (22)

According to Wiesman (32) (33), certain general facts about packaging have been learned which are helpful in extending the shelf-life of perishable products. When possible, meat should be cut and packaged under refrigeration. Refrigeration retards bacterial growth, and keeps meat in fresh condition with appetizing color for the maximum length of time. It is important to wrap the product very tightly so that as much air space as possible is eliminated, and the wrapping should be done as near to the time of sale as possible.

In his section on product care, Wiesman (33) makes the

following recommendations: "Proper handling of product during cutting, packaging, storage, shipment and display, is very necessary to insure protection of quality. All equipment including machinery, tables, floors and walls must be kept in a clean and sanitary condition at all times. Bacterial development and subsequent product deterioration in meat products can be kept at a minimum by proper temperature control." Wiesman (33) recommends the following temperatures during the course of the operation:

A. Cutting and Packaging Room Temperatures

Minimum 40°F - Maximum 45° F

B. Holding Room Temperatures

Minimum 34° F -Maximum 38°F

C. Retail Self-Service Case Temperatures

Minimum 34° F -Maximum 40°F

The above temperatures are offered by Wiesman only as a general guide, and variations due to operating procedure can be made without serious damage.

If it is possible to control the temperatures very closely, one should be cognizant of the proper temperatures for certain classes of meat products and segregate them into groups so that self-service cases may be set exactly for the products they contain.

A general classification according to proper holding-temperatures follows: (32)

A. Fresh Red Meats - 34° 36°F (Lamb should be held to a lower temperature than beef or veal)

B. Smoked Meats - 38°- 42°F (This class of products will keep at temperatures up to 45 F, but the lower temperature is recommended)

C. Fresh Pork Sausage- 34°F

D. Frankfurters - 36°F

E. Luncheon Meats - 36°F

F. Dry and Semi-dry Sausage - 38°- 42°F

At present most self-service cases fluctuate from 4-8 degrees F. and also vary at different heights in the case. To compensate for this rather wide fluctuation, Wiesman recommends that it may be necessary to set the temperature controls so that the low point of the cycle falls slightly above 32° F

The work by Hockman (22) Wiesman (32) and Wiesman and Hagen (33) seems to be the only published work on any of the technical problems of prepackaged self-service meats. There is voluminous literature on the technical aspects of frozen meat, but in very few cases are the problems and their solutions applicable to fresh prepackaged meat, although the problems in each case may be very much alike.

Most of the other published work on prepackaged self-service meat deals more or less with the economic aspects of the problems. One of the first studies was made by Gilchrist (19) during 1946. He was interested primarily in two main issues:

1. Consumer reaction to cellophane wrapped meats,
2. Comparative operating costs of self-service and conventionally operated or service, meat departments.

His article summarized existing data on the above issues, and in addition offered preliminary estimates of the prospects for lower distribution costs through prepackaging and self-service.

He was interested in consumer reaction to self-service because he says, "The question of the relative efficiency of prepackaged self-service and the conventional methods of retailing meat is largely academic if consumer acceptance to self-service meats cannot be established."

Table 2 summarizes the results of four surveys of consumer opinion.

Table 2* Consumer Acceptance of Prepackaged Self-Service Meat Departments as Shown by Field Surveys.

| Investigator | Type of Respondent | Percent of Respondents Indicating Willingness to buy Prepackaged Meat |
|---|---|---|
| DuPont (3) | Prepackaged Self-Service Patron | 87 |
| Gilchrist | " " " | 85 |
| Gilchrist | " " " | 89 |
| Gilchrist | Service Department Patron | 63 |

* (19)

More concrete evidence that consumers will buy prepackaged meats is in the increased sales experienced by nearly every meat department converted to self-service. The DuPont (3) survey gives the following scattered reports:

New England Retailer

30 percent increase over old type service

Mid-West Retailer

35 percent increase over old type service

Mid-West Retailer

50 percent increase over old type service.

West Coast Retailer

60 percent increase over old type service

This study by DuPont (3) gives no details as to time interval, comparability of merchandise, how survey sample was taken or percentages determined.

Gilchrist (20) found, in the Los Angeles area, meat sales increased on the average 61 percent within three months following conversion to self-service merchandising. His survey included seven of the eight self-service markets in operation in southern California as of July 1946. The data were taken directly from the accounting records of the firms cooperating in the study. The stores were large super markets having weekly meat sales from $3,500 to over $20,000.

The range of increase in sales was between 10 and 100 percent. There was only one store that showed a decrease in sales, and in that case the store was rather small and was located in a very high income area.

In his cost studies Gilchrist (20) used the following criteria to measure the efficiency of the stores:

1. ratio of direct labor cost to net sales 2. sales per man hour 3. sales per square foot of floor space used in the meat merchandising operation. The following chart shows the summarized results of the seven stores. All figures have been converted to index numbers.

Table 3. * Summary of Changes in Efficiency Experienced by Meat Departments Converting to a Prepackaged Self-Service Basis

| Item | Immediately Before Conversion | Immediately After Conversion | June 1946 | Nov-Dec. 1946 |
|---|---|---|---|---|
| Direct Labor Cost | 100 | 74 | 72 | 83 |
| Sales per Man Hour | 100 | 115 | 144 | 156 |
| Sales per Square Foot | 100 | 97 | 149 | 112 |

* (20)

The results show a reduction of 26 percent in direct labor cost, and an increase of 15 percent in sales per man hour. This would indicate a higher efficiency in these packaged self-service stores when compared with their previous type of merchandising.

The first of the Armour Surveys edited by Shafer (24) was published in May 1948. He was interested in the number of self-service stores, their location, and the weekly meat volume of each unit. The report also was quite detailed on what usually happened when a store converted to prepackaged self-service meat merchandising.

Sales, he found, went up especially on certain items, such as offal products, cold cuts, smoked meats and poultry.

Pigs feet, tripe, liver, soup bones, stew meat and similar items take on a special sales appeal when prepackaged in a transparent wrapper and displayed in a self-service case. Many a housewife, while reluctant to ask the meat retailer for such items, may select them in a self-service case, particularly when they are attractively packaged.

Shafer (24) found that the percentage of gross profit generally went down in the beginning after conversion to self-service meats. The need, in self-service, to adhere closely to exact weights, and to give more attention to customer requirements in trim and cut of the meat may be the cause of a lower percentage of gross profit.

Shafer (24) considers actual merchandising costs the most elusive factor to determine. Generally speaking, costs go up when the retailer first gets into prepackaged self-service meats. His cost of wrapping materials is higher and frequently his labor costs are more. It is generally conceded that a self-service meat operation does not necessarily result in lowered costs.

Shafer considered Gilchrist's (19) studies on costs and efficiency very inconclusive, and did not prove conclusively that costs were significantly lower in self-service merchandising. Gilchrist's (19) study did indicate that operators of self-service stores prefer this method of

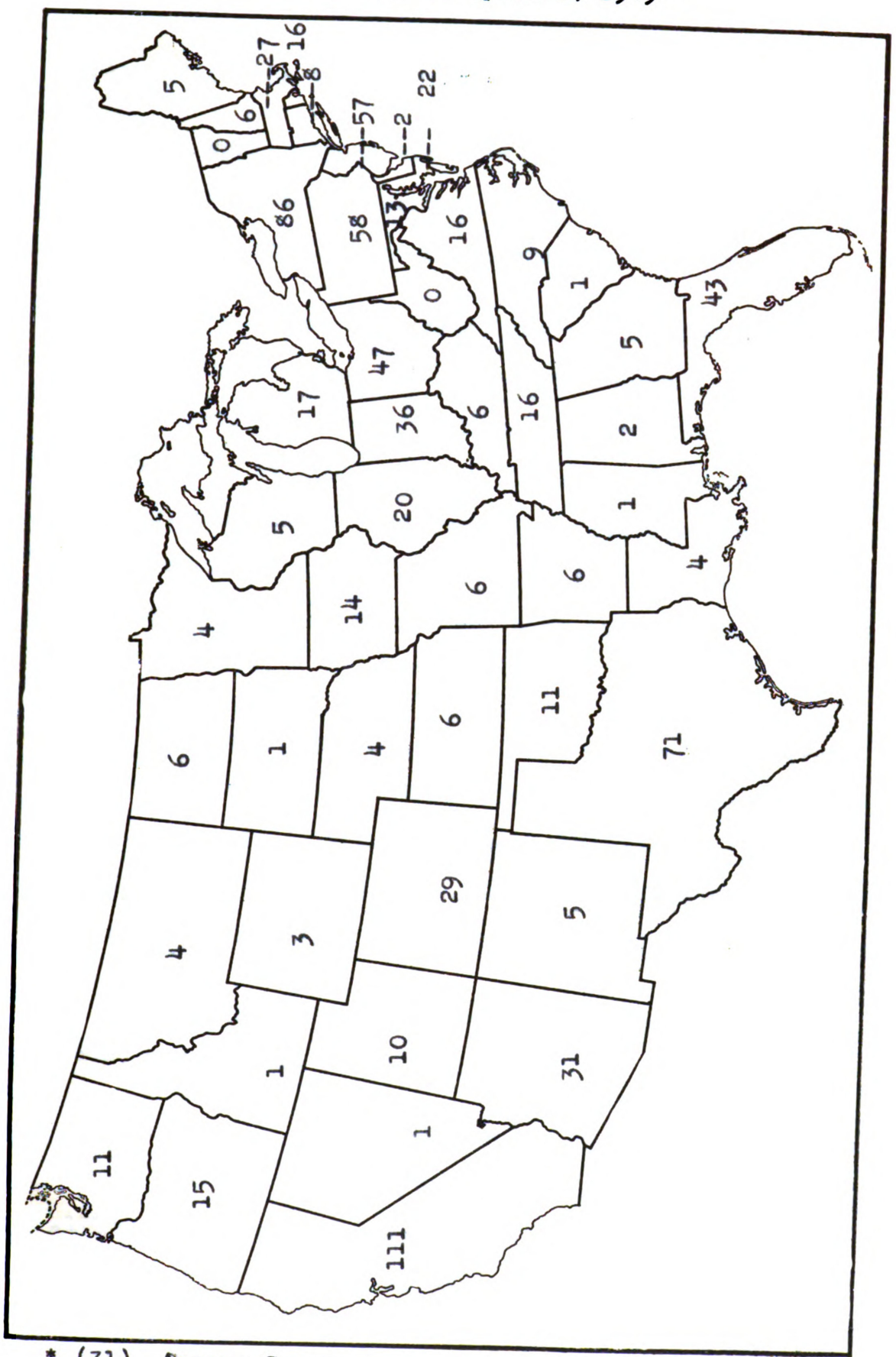
merchandising meat and that the consumers like to buy meats the self-service way.

In the Armour Report of May,1949, edited by Tittleman (31), he said the attention has shifted to new and different aspects of the self-service problem. During 1948, interest was primarily in whether self-service was successful, whether consumers liked self-service, and what happened when retailers converted to self-service. Now in 1949, Tittleman says that the interest on the part of retail merchants has turned largely to improvements in production and layout, the ways and means of reducing costs, to more efficient and better controlled operations in every phase of self-service meats.

There were approximately 200 self-service stores as of April 1, 1948. Six months later this figure had doubled. By April 1, 1949, the number had increased to 878, or over four times the figure of one year earlier. Self-service meat departments are opening at the rate of about 75 every month.

While the number of self-service stores has been expanding rapidly, these stores do only a small percentage of the total food business. Chains on a self-service meat basis account for about five percent of the total chain store volume, independently owned units on a self-service basis account for less than two percent of the independent volume. Together, the 878 stores do a little over two

Number and Location of 100% Self-Service Meat Stores
as of April 1, 1949 *




* (31) Armour Survey

Figure 4

percent of the total dollar volume of all types of food stores.

In April, 1948, there were 13 states that did not have a self-service meat department. As of April, 1949, only Vermont and West Virginia were in this class. (Figure 4 ).

Self-service meat retailing is confined primarily to large volume stores. More than 50 percent of all self-service meat stores are owned by chains. About 10 percent are operated by national chains, 42 percent are important sectional or regional chains, and less than five percent are owned by local chains. Of the 878 self-service stores, 43 percent are new stores and 57 percent have been converted to self-service meats.

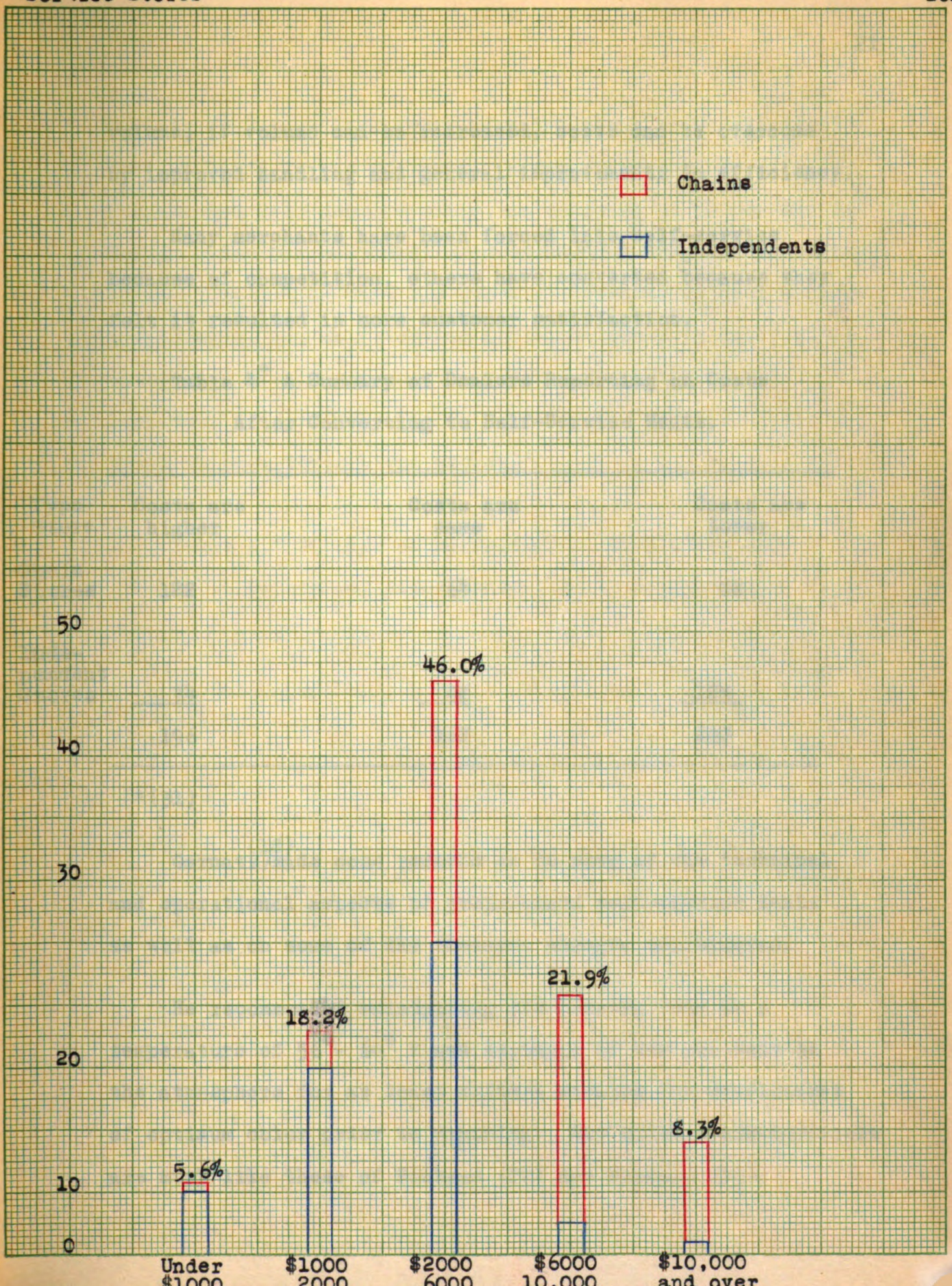
The heavy traffic, large volume stores dominate the self-service picture. Only one in twenty stores does under $1000 per week in meat sales and only one in five from $1000 to $2000 per week. Nearly one out of every two self-service stores does a weekly meat volume between $2000 and $6000.

A good portion of the self-service stores do better than $6000 per week in meats. (Figure 5).

Tittleman (31) made a rather extensive survey on costs. Costs, it seems, command the interest of most every one, although with some operators costs are not the main consideration. Some feel that the most important item is

Percent Self-Service Stores

# Large Volume Stores Dominate Self-Service Picture



volume, if volume can be increased, costs can be overcome by improved handling and general improvements in efficiency.

Many merchants have been forced into self-service because of competition, others have converted because they felt it resulted in more customer satisfaction.

Table 4* A Summary of Dealers Reporting on Costs After Converting to Self-Service Meats.

| Type Store | Costs are higher | Costs are same | Costs are lower |
|---|---|---|---|
| Chain Stores | 122 | 64 | 82 |
| Independent Stores | 74 | 98 | 125 |
| | 196 | 162 | 207 |

*(31)

Garnatz(18) made some remarks as to some of the technical and operational aspects of prepackaged self-service meats as well as on some of the economic changes encountered.

He recommended maintaining the cutting room at a temperature of 56°- 60° F and exposure of the cut meat to the atmosphere for at least fifteen minutes for development of optimum color prior to wrapping. His other recommendations are much like those of Hockman (22) and Wiesman (33).

Garnatz (18) says, "consumer acceptance has been indicated very strongly in the following: after conversion to a prepackaged self-service basis, an increase of 94 percent in dollar sales has resulted, or a 49 percent increase in tonnage. As an illustration that the overall increases enjoyed through prepackaging and self-service are experienced in the various categories within the meat department,the following breakdown is pertinent and is based on the percent of the total tonnage through the stores."

Table 5 * Summary of percentage of Total Tonnage Before and After Conversion to Self-Service

| Item | Before Conversion | After Conversion |
|---|---|---|
| Poultry | 4.0% | 16.0% |
| Veal | 2.5% | 10.8% |
| Sausage | 8.6% | 11.2% |
| Bacon | 7.3% | 9.6% |

*(18)

Notice the very large increases in poultry and veal. No figures were given for beef or pork increases.

## EXPERIMENTAL PROCEDURE

Part one of this section is a summary report of the experimental work done at the Michigan State College Meats Laboratory.

The object was to test and compare the various wrapping materials used for their serviceability, color preservation, and drip and weight loss under controlled conditions.

The wrapping materials used were:

| | |
|---|---|
| 1. Cellophane | DuPont 300 M S A T-80 |
| 2. Aluminum Foil | .0015 inches (Thickness) |
| 3. Aluminum Foil | .0010 inches (Thickness) |
| 4. Aluminum Foil | .0007 inches (Thickness) |

The cellophane used was a product of the E.I. duPont deNemours and Company.

The aluminum foil was supplied by The Aluminum Company of America.

The backing boards, or stiffness, used were the Rodeo Prepackaging Boards, manufactured by the Southerland Paper Company.

All the meat used in this study was slaughtered and processed in the Michigan State College Meats Laboratory.

The following procedure was used in this section of

the study.

1. All meat used was aged and held at a temperature of from 34º 36°F. with a relative humidity of from 85 to 90 percent.

2. The meat to be wrapped was boned and cut in a room with a temperature of from 50°- 58°F.

3. The packages were wrapped when the temperature of the meat was from 40°- 46°F., in a room with an ambient temperature of 50°- 60° F.

4. The packages were stored in a room at a temperature between 34°- 36° F. with a relative humidity of from 85-90 percent.

In wrapping the packages the following procedure was followed:

1. The various wrapping materials were cut into sheets 9 x 15 inches.

2. The cut wrapping materials were weighed to the nearest 1/10 of a gram and numbered.

3. The backing boards were weighed to the nearest 1/10 of a gram and identified.

4. The meat was cut into steaks, weighed to the nearest 1/10 of a gram and then wrapped.

5. The standard storage temperature was 36°F with a relative humidity of 85 to 90 percent.

6. The standard storage periods were: 24 hours, 48 hours and 72 hours.

7. A drug store or confectioner's type wrap was used, cellophane tape was used to seal the packages.

8. All packages were placed in the storage room immediately after wrapping.

9. The packages were placed in single layers on shallow meat display trays.

10. When the packages were unwrapped after storage the meat was allowed to drip, or drain, for five seconds. This drip was permitted to fall on the wrapping material.

11. The meat was weighed, next the backing board, and after the cellophane tape was removed from the wrapping material, the material was weighed.

## TEST 48-2

A group of 44 steaks was used in this experiment.

The object was to find if there was any measurable difference in the shrink or drip loss when using the various types of wrapping materials.

The meat used for this test was a round from a high good grade steer carcass. The round was boned and separated into inside and outside sections. From the outside portion, 24 steaks were cut, and from the inside section, 20 steaks were obtained.

A summary of the results is shown in Table 6:

Table 6. The Percentage of Shrink of Round Steaks*

| Hrs. | Outside Round Wrapping Materials | | | | Inside Round Wrapping Materials | | | |
|---|---|---|---|---|---|---|---|---|
| | Al. Foil .0015" | Al. Foil .0010" | Al. Foil .0007" | Cellophane | Al. Foil .0015" | Al. Foil .0010" | Al. Foil .007" | Cellophane |
| 24 | 0.81 | 1.68 | 0.83 | 1.79 | 1.09 | 1.52 | 0.74 | 1.58 |
| 48 | 1.01 | 1.32 | 1.06 | 1.85 | 1.66 | 0.67 | 1.46 | 1.75 |
| 72 | 1.21 | 1.85 | 1.19 | 2.53 | 1.19 | 1.69 | 1.45 | 2.44 |
| Average | 1.01 | 1.38 | 1.02 | 2.06 | 1.27 | 1.45 | 1.33 | 2.13 |

* Appendix A

The color of the meat on being unwrapped was found to be acceptable in all of the packages. It was noted, when using the aluminum foils, that care had to be taken to remove all air pockets. It appeared that air pockets caused localized surface discoloration of the meat. This was due, no doubt to an oxidation or an electrolytic reaction which was not obtained when all the air was excluded from the package by using a tight wrap. If all of the air was excluded from the package, the color was found to be excellent when using aluminum foil.

The lightest guage aluminum foil (.0007") lacked sufficient tensile strength to permit for tight wrapping. With this light weight foil it was very difficult to handle without tearing or making finger holes in the sheets.

## TEST 49-11

This test was analyzed for variance to determine if the differences in the shrink or drip loss, was due to the different wrapping materials, storage periods, or to experimental error.

The meat used in this experiment was a round from a low choice grade steer. The round was boned and divided into inside and outside sections. The two portions were cut into 36 steaks, one at a time, weighed and then wrapped.

The order in which the wrapping materials were applied was randomized.

The packages were placed into three groups. Each group consisted of twelve packages, three packages of meat wrapped in each of the four wrapping materials.

In analyzing this group for variance, the following results were obtained:

Table 7 Analysis of Variance of Test 49-11 ***

| Source | DF | SS | MS | F |
|---|---|---|---|---|
| Total | 35 | 4.6461 | | |
| Material | 3 | 1.2432 | .4144 | 4.630** |
| Period | 2 | 0.7194 | .3597 | 4.019 * |
| Balance (within) | 30 | 2.6835 | .0895 | |

* Significant
** Highly Significant
*** Appendix B

The preceding two tests show the general trend found in this study. There were 16 separate experiments conducted in this part of the study. When pork boston butt slices were used, the following weight data were obtained: *Appendix C

| | |
|---|---|
| Cellophane M S A T -80 | 2.48% |
| Aluminum Foil .0015" | 1.35% |
| Aluminum Foil .0010" | 1.45% |
| Aluminum Foil .0007" | 1.51% |

Experiments were conducted using small bone-in and boneless beef cuts. It is obvious that the greater the area of the cut surface the greater the drip loss will be, but when using small steaks, very little difference was noted.

## TEMPERATURE STUDIES

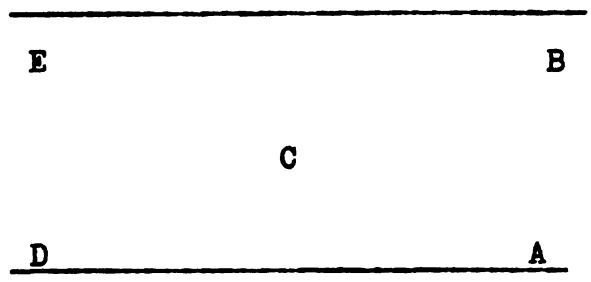
The second section of this study was a more or less practical approach to some of the operational problems found with self-service meat merchandising.

This part of the study was carried out in two units of a local chain organization.

The first objective was to check the temperatures of the display cases to see what the fluctuation was at different times, and to discover the variation of the

temperatures within the five cases. Each case was divided into sections for uniformity of area.

Figure 6. Diagram Showing Division of Case into Areas for Checking Temperatures.




The temperatures were found to be as follows:

Table 8 Average Temperatures of Display Cases in Degrees Fahrenheit *

| Trial | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | 38.0° | 38.8° | 39.2° | 36.4° | 38.8° |
| 2 | 35.6° | 34.6° | 35.6° | 35.2° | 35.6° |
| 3 | 35.2° | 35.4° | | 35.0° | 34.2° |
| Average | 36.3° | 36.3° | 37.4° | 35.5° | 36.2° |

* Appendix D

The overall average for all cases was 36.3°F. This temperature is within the limits recommended by Wiesman (32).

The temperature of the packaged meat in the cases varied 4° F. The lowest temperature found was 38° F and the

highest was 42°F . Some of the variation was due to the location of the packages, and the amount of handling the packages received. The temperatures shown in Table 9, were found with a controlled experiment, that is, the temperatures of the meat were known when placed in the case; a location check was made of each package, the length of display case storage was known, and the temperature of each package was checked while it was in the case.

Table 9. Chart Showing Hours in Case and Temperatures. Found in Packages of Beef Round Steak

| Hours in Display Case | Temperature in ° F. of package when put in case | Temperature in ° F of packages when removed from case |
|---|---|---|
| 24 | 48° | 38° |
| 24 | 48° | 42° |
| 48 | 48° | 38° |
| 48 | 52° | 38° |
| 72 | 54° | 40° |
| 72 | 48° | 42° |

The next objective was to follow the temperature changes of the meat as it was processed through the cutting and wrapping operations. Temperatures were taken during the following operations:

1. When wholesale cuts were taken out of the cooler.
2. When the meat was cut.

3. When placed on display trays to be returned to the holding room.
4. At the time of being wrapped.
5. When the packages were placed in the display cases.

In the cooperating market the wholesale cuts were removed from the cooler and placed on a meat block to be trimmed. After this operation they were made into retail cuts on an electric meat saw. The retail cuts were placed on a meat block until all of the cutting was completed, then they were placed on display trays to be returned to the holding room cooler for development of optimum color, or approximately one-half hour. It was observed during this operation that the meat may be at room temperature for a period of from one-half hour to as long as two hours, permitting the temperature to rise as much as $10^{\circ}$ or $12^{\circ}$ F.

Another cause of high temperatures was observed to be the lag in the wrapping and weighing operations. It was noted that there were temperature rises of as much as $16^{\circ}$ F during this operation while the meat was not under refrigeration. Some of the observations are shown in Table 10:

Table 10. Temperature of Meat During Various Phases of the Packaging Operation.

| Type of Meat | Removal from Cooler | Cut | Returned to Holding Cooler | Wrapped | Placed in Display Case |
|---|---|---|---|---|---|
| Pork Chops | 36 ° | 38 ° | 46 ° | 42 ° | 48 ° |
| Pork Chops | 38 ° | 41 ° | 48 ° | 40 ° | 43 ° |
| Pork Chops | 35 ° | 42 ° | 48 ° | 46 ° | 54 ° |
| Pork Shoulder | 36 ° | 41 ° | 44 ° | 54 ° | - |
| Beef Round Steak | 35 ° | 39 ° | 39 ° | 38 ° | 46° |
| Beef Sirloin Steak | 36 ° | 39° | 41 ° | 46 ° | - |
| Beef Chuck Roast | 38 ° | 41° | 44 ° | 40° 46° | 48°- 56° |
| Ground Beef | 34 ° | - | - | 46 ° | 54 ° |
| Ground Beef | - | - | 44 ° | 52 ° | 58 ° |
| Chop Suey Meat | - | 40° | - | 55°- 58° | 63°- 65° |
| Stew Meat | - | 36° | - | 48° | 56° |

## Tests 49- M1 and 49- M4

The object of these two tests was to find the shrinkage or drip loss of prepackaged meat when handled under typical commercial conditions, and to compare these observations with those obtained under controlled conditions in the laboratory.

For test 49-M1 an outside round section from a low good grade

heifer carcass was used to obtain 12 steaks.

The steaks were cut by the meat cutter, placed on display trays and taken to the holding room for one-half hour. However, in this study the meat was weighed after being cut and again just prior to being wrapped.

Using a Rodeo backing board the packages were wrapped in DuPont 300 M S A T-80 cellophane and heat sealed. The regular employees wrapped these packages.

The packages were then placed in the display cases, with care being taken to distribute the packages throughout the five cases. Each day for three days, four packages were removed and weighed immediately. Weight loss date are shown in Table 11:

Table 11. Percent Shrinkage of Round Steak Wrapped in Cellophane and Placed in a Commercial Self-Service Display Counter *

300 M S A T #80 was used for wrapping

| | 24 Hours | 48 Hours | 72 Hours |
|---|---|---|---|
| | 1.86 | 3.50 | 4.44 |
| | 3.15 | 3.46 | 3.73 |
| | 1.83 | 3.43 | 3.52 |
| | 2.74 | 3.04 | 3.57 |
| Average | 2.39 | 3.35 | 3.81 |

Average all groups 3.18

* Appendix E

In test 49-M4 the same general operating procedure was followed as with 49-M1 with the following exceptions: Lamb shoulder chops, from a medium choice grade lamb carcass, aged for 12 days at 34° F were used. The wrapping materials were: 300 M S A T-80 cellophane, .0015" aluminum foil, .0010" aluminum foil and .0007" aluminum foil. The object of using the various wrapping materials was to compare the results obtained under commercial conditions with those observed in the laboratory. With this group the author did the cutting and wrapping, and the cut chops were not held in a holding room but were weighed and wrapped immediately after being cut.

The following results were obtained:

Table 12. Percent Shrinkage of Lamb Shoulder Chops in Various Wrapping Materials Placed in a Commercial Self-Service Display Case.

| Wrapping Material | Hours 24 | Hours 48 | Hours 72 | Average for Material |
|---|---|---|---|---|
| Cellophane MSAT-80 | 1.20 | 2.94 | 3.63 | 2.59 |
| .0015" Aluminum Foil | 1.25 | 2.26 | 1.74 | 1.75 |
| .0010" Aluminum Foil | 1.23 | 1.59 | 2.20 | 1.67 |
| .0007" Aluminum Foil | 1.06 | 1.67 | 2.16 | 1.63 |
| Average for Period | 1.19 | 2.12 | 2.43 | 1.91 |

The color was acceptable in all packages. The aluminum foil wrapped packages withstood handling very well, there

were no large holes or tears noted when the packages were unwrapped. However, small pin holes were found as well as small tears in the creases and folds particularly in the .0007" aluminum foil wrapped packages.

## Rewrapped and Remerchandised Packages

This section of the study dealt with rewrapped and remerchandised packages. To define our terms:

1. A rewrapped package is one that was unsold because of a wrapping material deficiency, excessive weepage or drip, or through reasons other than deterioration of quality of the product the package must be rewrapped.
2. A remerchandised package is one that was unsold due to deterioration in quality of the original product. In this case the meat may be discarded or it may be remerchandised and sold as another product.

The object of this survey was to determine a normal percentage for rewrapped and remerchandised packages that could be used as an operation standard.

A count was taken of all packages wrapped, those that were rewrapped and those that had to be remerchandised. In this section the author admits to some error in observation, but believes the figures are accurate enough to indicate a

a trend which may be used as a comparison or starting point for future studies of this type.

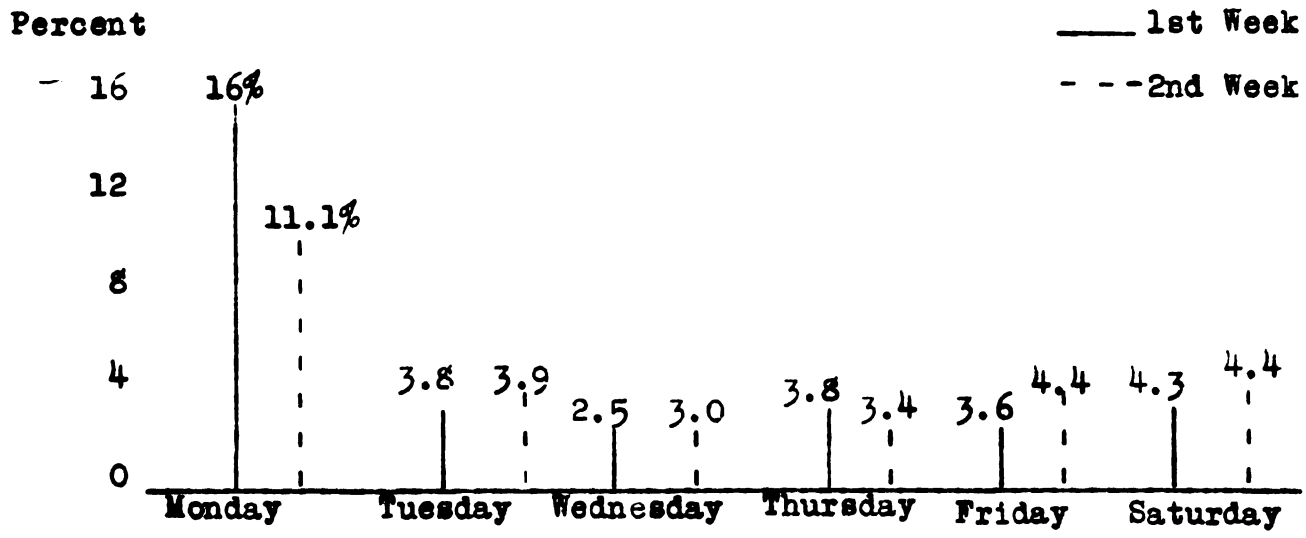
The following observations were made for a two weeks period:

Table 13. Table of Wrapped, Rewrapped and Remerchandised Packages for a Two Weeks Period

| Day | Packages Wrapped | Packages Rewrapped | %of Packages Rewrapped | Packages Reworked | % of Packages Reworked |
|---|---|---|---|---|---|
| Monday | 1025 | 164 | 16.0 | 51 | .50 |
| Tuesday | 741 | 28 | 3.8 | 14 | .20 |
| Wednesday | 631 | 16 | 2.5 | 4 | .10 |
| Thursday | 1462 | 56 | 3.8 | 5 | .03 |
| Friday | 1312 | 47 | 3.6 | - | - |
| Saturday | 1487 | 64 | 4.3 | 6 | .04 |
| Weekly Av. | 6658 | 375 | 5.6 | 80 | .12 |
| Monday | 1121 | 124 | 11.1 | 35 | .30 |
| Tuesday | 824 | 32 | 3.9 | 8 | .10 |
| Wednesday | 712 | 22 | 3.0 | 9 | .10 |
| Thursday | 1284 | 44 | 3.4 | 5 | .04 |
| Friday | 1400 | 62 | 4.4 | 8 | .06 |
| Saturday | 1346 | 59 | 4.4 | 11 | .08 |
| Weekly Av. | 6687 | 343 | 5.0 | 76 | .11 |
| Two Weeks | 13345 | 718 | | 156 | |
| Average | 6673 | 359 | 5.4 | 78 | .12 |

To summarize Table 13, Figure 10 will be used.

Figure 10. Percentage of Total Packages Rewrapped Daily




Monday usually had the largest number of packages that needed to be rewrapped and remerchandised. This was due to the close scrutiny each package received on the opening of business Monday morning. Each package carried over the week end was checked and any showing wrapping deficiencies were removed from the cases to be rewrapped,or remerchandised as the case may be.

Tuesday and Wednesday were found to have the smallest percentage of packages needing rewrapping as handling was at a minimum. On the week end business of Friday and Saturday the number of rewrapped packages increased, while the number to be remerchandised decreased. This can be explained by the increased handling and rapid turn over of the packages.

It is the opinion of the author that in the store

surveyed the number of packages that were rewrapped and remerchandised was not excessive.

## Consumer Purchases

In concluding this problem a survey was made in an effort to find out what and how many items the consumer purchased when buying prepackaged self-service meat.

The survey was conducted in the following manner: All customers and their meat purchases were counted as they were checked through the check-out counters. This location was chosen because here the items were laid out and could be checked quite readily.

Figure 11 Form Used to Make Self-Service Meat Purchase Survey

| Number | Sex | | Meat Purchase Made | | Red Meats | Luncheon Meats | Other Meat Items |
|---|---|---|---|---|---|---|---|
| | M. | F. | Yes | No. | No. Packages | No. Packages | No. Packages |
| 1 | x | | x | | 1 | 2 | 1 |
| 2 | | x | | x | - | - | - |
| 3 | | x | x | | 2 | 0 | 0 |

Red meat included all fresh meat items; luncheon meats included all items of a ready to eat nature such as baked loaves, frankfurters, salomi, etc; other meat items included smoked meats, bacon and other meats not covered in the other two classes. Poultry, fish, cheese and other non-meat items were not counted in this survey.

The survey was conducted in two stores on two separate days.

The results are summarized in Table 14.

Table 14. Tabulation of Self-Service Meat Purchase Survey

| No. | Sex | | Meat Purchase Made | | Red Meats | | Luncheon Meats | | Other Meat Items | |
|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | Yes | No | No. Purchasing | No. Pkgs. | No. Purchasing | No. Pkgs. | No. Purchasing | No. Purchased |
| 100 | 29 | 71 | 62 | 38 | 33 | 61 | 35 | 65 | 39 | 52 |
| 100 | 24 | 76 | 67 | 33 | 47 | 78 | 45 | 81 | 32 | 39 |
| 100 | 33 | 67 | 65 | 35 | 39 | 59 | 29 | 39 | 32 | 34 |
| 100 | 36 | 64 | 56 | 44 | 40 | 62 | 17 | 31 | 24 | 27 |
| Average | 30.5 | 69.5 | 62.5 | 37.5 | 39.8 | 65.0 | 31.5 | 54.0 | 31.8 | 38.0 |
| Average No. Purchased | | | | | | 1.6 | | 1.7 | | 1.2 |

This survey showed that 62.5 per cent of the customers purchased some meat item. The average meat purchaser purchased 2.5 packages of meat.

## SUMMARY AND CONCLUSIONS

1. The average shrink or drip loss for the various wrapping materials were : ( average for all experimental trials)

| | | |
|---|---|---|
| Cellophane | M.S.A.T. 80 | 2.09% |
| Aluminum Foil | .0015" | 1.14% |
| Aluminum Foil | .0010" | 1.42% |
| Aluminum Foil | .0007" | 1.18% |

2. Aluminum foil is a very efficient wrapping material when shrinkage or drip loss is considered. However, this advantage is out weighed because of the non-transparancy of the material.

3. The stacking and handling of packages increased the percent of drip loss.

4. To prevent large fluctuations in meat temperatures the cutting and wrapping operations must be conducted with dispatch, there should be no lag phase where the meat is not under refrigeration for extended periods.

5. Under commercial operations it was found necessary to rewrap approximately five percent of the packages, this included broken and torn packages as well as those that were unattractive.

6. About 0.12 percent of the packages had to be removed

from the display cases and be remerchandised.

7. The greatest number of packages were rewrapped and remerchandised on Monday. Friday and Saturday had the greatest number of broken or torn packages, but had the lowest number of packages to be remerchandised.

8. The average meat purchaser purchased 2.5 packages of meat.

# BIBLIOGRAPHY

# BIBLIOGRAPHY


1. Anonymous
   1948 Aluminum Foil Ham Wrappers. The National Provisioner. 119, November 20:35.

2. Anonymous
   1948 How to Pre-Package Meat. E.I.du Pont de Nemours and Company, Wilmington, Delaware. 24 pp.

3. Anonymous
   1948 Self-Service Meat. E.I. du Pont de Nemours and Company, Wilmington, Delaware. 45 pp.

4. Anonymous
   1948 Increased Sale of Pre-Packaged Meats. The National Provisioner. 119, September 25:12.

5. Anonymous
   1948 Meat Pads. The National Provisioner. 119, August 14:42.

6. Anonymous
   1948 Observations on Changes in Color of Fresh Meat. The National Provisioner. 119, October 23:18.

7. Anonymous
   1948 Pre-Packaged Cut Meateria. The National Provisioner. 119, August 21:34.

8. Anonymous
   1948 Self-Service Within a Self-Service Market. Butchers Advocate. August 11:28

9. Anonymous
   1948 Selling More With Greater Profit Through Better Packaging. The National Provisioner. 119,

10. Anonymous
    1949 Is the Meat Industry on a Threshold of a Market Revolution? Sales Management, 62, January 15:37.

11. Bjorka, Knute
    1945 Marketing Margins and Costs for Livestock and Meat. United States Department of Agriculture, Tech. Bul. No. 932. Washington: Government Printing Office, 1947. 102 pp.

12. Bonini, John
1948 Improving Profits Through Packaging. Reprint of speech presented at the American Meat Institute Meeting, New York, New York, September 20. 10 pages.

13. Chamberlain, C.C., and Bratzler, L.J.
1948 Report on Hope-Flanagan Project 1-A, 1947-1948. Michigan Agricultural Experiment Station Animal Husbandry Department, mimeographed publication, 13 pages.

14. Clemens, R.A.
1923 The American Livestock and Meat Industry. The Ronald Press, New York. 872. pp.

15. Dickie, Jack W.
1948 The Future of Pre-Packaged Meat. Reprint of speech presented at The National Association of Retail Grocers' Convention, Atlantic City, New Jersey, June 22, 1948. 8 pages.

16. Dipman, Carl, and Lucas, John D.
1949 The Pros and Cons of Self-Service Meat Operations. The Progressive Grocer, April:68.

17. Edwards, J.D., and Strohm, D.B.
1947 Aluminum Foil. Aluminum Company of America, Pittsburgh, Pa. 18 pp.

18. Garnatz, George
1949 A Review of Packaging in Connection with Retailing Meats. Reprint of speech given at The American Meat Institute Meeting, Chicago, Illinois, April 17. 8 pages.

19. Gilchrist, F.W.
1948 An Analysis of Pre-Packaged and Self-Service as a Means of Lowering Costs of Retailing Meat and Delicatessen Products. A copy of a dessertation presented to the faculty of the Department of Economics, University of Southern California, Los Angeles, June, 1948. 10 pages.

20. Gilchrist, F.W.
1949 Self-Service Retailing of Meat. The Journal of Marketing. 13(3):295-304.

21. Hinman, Robert B., and Harris, Robert B.
1939 The Story of Meat. Swift and Company, Chicago. 291 pp.

22. Hockman, Robert O.
1946 Problems in Packaging Meat Products. Reprint of speech presented at The National Independent Meat Packers' Convention, Chicago, April 12. 16 pages.

23. Schueren, Arnold C.
1927 Meat Retailing. Vaughn Company, Chicago. 836 pp.

24. Shafer, W.S.
1948 Pre-Packaged Self-Service Meats. Armour and Company, Chicago. 36 pp.

25. Shafer, W.S.
1948 Meat Packer Surveys Self-Service Meat Development. The National Provisioner. 119, October 2:130, and Super Market Merchandising, 13, June:101, and 13, October:77.

26. Shepherd, Gregory S.
1947 Marketing Farm Products. Iowa State College Press, Ames, Iowa, pp. 179-257.

27. Steele, L.B.
1946 Self-Service Spurs Pre-Packaging Trend. Reprint of speech presented at the Conference of The American Management Committee, Atlantic City, New Jersey, April 7,1946. 8 pages.

28. Swift, Louis F.
1927 The Yankee of the Yards. A.W. Shaw and Company, London, England. 218 pp.

29. Teitelman, Sam
1949 Self-Service Meats. The National Provisioner. 120, May 14:36.

30. Teitelman, Sam
1949 Packer Surveys Trends in Self-Service Meats. The National Provisioner. 120. May 21:15.

31. Teitelman, Sam
1949 Pre-Packaged Self-Service Meats. Armour and Company, Chicago. 31 pp.

32. Wiesman, C.K.
1947 Packaging Supplies, Equipment, and Product Care of Meats for Retail Self-Service. Armour and Company, Chicago, mimeographed publication, 12 pages.

33. Wiesman, C.K., and Hagen, R.F.
1949 Technical Aspects of Self-Service Meats. Armour and Company, Chicago, mimeographed publication, 21 pages.

34. Williams, E.E.
1945 Merchandising Frozen Meats. Reprint of speech presented at a convention of The American Meat Institute, Chicago, October 30,1945. 8 pages.

# APPENDIX

APPENDIX A

Test 48-2 Outside Round

| No. | Material Used | Hours in Storage | Wt. Meat in Grams | | Wt. Board Grams | | Wt. Wrapping Material in Grams | |
|---|---|---|---|---|---|---|---|---|
| | | | Original | Removed | Original | Removed | Original | Removed |
| 1 | Cellophane | 48 | 183.7 | 180.0 | 7.5 | 9.8 | 3.5 | 4.2 |
| 2 | Cellophane | 48 | 216.4 | 212.7 | 7.4 | 9.6 | 3.5 | 4.2 |
| 3 | Cellophane | 72 | 260.5 | 254.3 | 7.5 | 10.9 | 3.5 | 4.9 |
| 4 | Cellophane | 24 | 253.1 | 249.5 | 7.4 | 9.9 | 3.4 | 4.3 |
| 5 | Cellophane | 72 | 167.4 | 162.9 | 7.5 | 10.1 | 3.6 | 4.8 |
| 6 | Cellophane | 24 | 143.7 | 140.6 | 7.5 | 9.9 | 3.6 | 4.6 |
| 7 | .0010" Al.F. | 48 | 170.3 | 167.7 | 7.5 | 9.8 | 6.8 | 7.7 |
| 8 | .0010" Al.F. | 24 | 182.4 | 179.2 | 7.6 | 9.6 | 7.2 | 8.6 |
| 9 | .0010" Al.F. | 48 | 289.5 | 286.2 | 7.4 | 10.3 | 7.3 | 7.8 |
| 10 | .0010" Al.F. | 24 | 257.9 | 255.3 | 7.4 | 9.5 | 7.4 | 7.9 |
| 11 | .0010" Al.F. | 72 | 234.0 | 230.5 | 7.5 | 10.2 | 6.9 | 8.2 |
| 12 | .0010" Al.F. | 72 | 197.1 | 194.3 | 7.5 | 10.1 | 7.5 | 7.9 |
| 13 | .0007" Al.F. | 48 | 308.6 | 305.1 | 7.6 | 10.6 | 5.1 | 5.8 |
| 14 | .0007" Al.F. | 24 | 287.3 | 285.3 | 7.4 | 9.2 | 5.3 | 5.8 |
| 15 | .0007" Al.F. | 24 | 207.7 | 205.7 | 7.3 | 9.2 | 5.5 | 6.1 |
| 16 | .0007" Al.F. | 48 | 191.8 | 189.9 | 7.5 | 9.7 | 5.1 | 5.7 |

APPENDIX A-CONTINUED

Test 48-2

| No. | Material Used | Hours in Storage | Wt. Meat in Grams | | Wt. Board in Grams | | Wt. Wrapping Material in Grams | |
|---|---|---|---|---|---|---|---|---|
| | | | Original | Removed | Original | Removed | Original | Removed |
| 17 | .0007" Al.Fl. | 72 | 189.5 | 187.3 | 7.5 | 9.9 | 5.3 | 6.0 |
| 18 | .0007" Al.Fl. | 72 | 131.6 | 130.0 | 7.3 | 9.3 | 5.3 | 5.9 |
| 19. | .0015" Al.Fl. | 48 | 251.5 | 248.7 | 7.8 | 10.1 | 10.9 | 11.7 |
| 20 | .0015" Al.Fl. | 48 | 260.8 | 259.4 | 7.4 | 9.7 | 11.7 | 12.2 |
| 21 | .0015" Al.Fl. | 24 | 269.0 | 266.9 | 7.8 | 9.7 | 11.7 | - |
| 22 | .0015" Al.Fl. | 24 | 191.0 | 189.4 | 7.4 | 9.1 | 11.3 | 11.5 |
| 23 | .0015" Al.Fl. | 72 | 170.7 | 168.9 | 7.7 | 10.1 | 11.4 | 12.0 |
| 24 | .0015" Al.Fl. | 72 | 159.9 | 157.9 | 7.3 | 9.3 | 11.0 | 11.5 |

APPENDIX A--Continued

Inside Round

| No. | Material Used | Hours in Storage | Wt.Meat in Grams | | Wt.Board Grams | | Wt.Wrapping Material in Grams | |
|---|---|---|---|---|---|---|---|---|
| | | | Original | Removed | Original | Removed | Original | Removed |
| B1 | Cellophane | 24 | 283.8 | 279.3 | 8.0 | 10.3 | 3.5 | 4.4 |
| B2 | Cellophane | 72 | 306.5 | 299.7 | 7.7 | 10.6 | 3.5 | 4.3 |
| B3 | Cellophane | 48 | 290.3 | 285.4 | 7.6 | 10.7 | 3.3 | 4.5 |
| B4 | Cellophane | 72 | 320.4 | 313.0 | 7.8 | 12.2 | 3.5 | 5.5 |
| B5 | Cellophane | 72 | 315.6 | 306.8 | 7.9 | 12.1 | 3.5 | 4.6 |
| B6 | .0010" Al. Fl. | 48 | 251.2 | 249.5 | 8.0 | 10.0 | 6.8 | 7.5 |
| B7 | .0010" Al. Fl. | 24 | 355.5 | 350.9 | 7.7 | 11.1 | 7.2 | 8.7 |
| B8 | .0010" Al. Fl. | 72 | 338.0 | 332.3 | 8.1 | 12.1 | 7.0 | 8.8 |
| B9 | .0010" Al. Fl. | 72 | 389.9 | 383.0 | 8.0 | 12.9 | 7.6 | 9.1 |
| B10 | .0010" Al. Fl. | 72 | 384.9 | 379.0 | 8.3 | 12.9 | 7.1 | 8.2 |
| B11 | .0007" Al. Fl. | 48 | 334.5 | 329.6 | 8.2 | 11.8 | 5.2 | 6.3 |
| B12 | .0007" Al. Fl. | 24 | 325.5 | 323.1 | 8.2 | 10.6 | 5.1 | 5.7 |
| B13 | .0007" Al. Fl. | 72 | 345.8 | 340.8 | 8.1 | 11.9 | 5.5 | 6.5 |
| B14 | .0007" Al. Fl. | 72 | 198.2 | 194.7 | 7.9 | 10.7 | 5.3 | 6.2 |
| B15 | .0007" Al. Fl. | 72 | 245.2 | 242.2 | 8.2 | 11.2 | 4.9 | 5.5 |
| B16 | .0015" Al. Fl. | 72 | 292.5 | 289.2 | 8.2 | 10.5 | 11.3 | 12.2 |

APPENDIX A- Continued

| No. | Material Used | Hours in Storage | Wt. Meat in Grams Original | Wt. Meat in Grams Removed | Wt. Board Grams Original | Wt. Board Grams Removed | Wt. Wrapping Material in Grams Original | Wt. Wrapping Material in Grams Removed |
|---|---|---|---|---|---|---|---|---|
| B17 | .0015" Al.Fl. | 24 | 301.3 | 298.0 | 8.2 | 10.9 | 11.0 | 11.6 |
| B18 | .0015" Al.Fl. | 72 | 238.5 | 235.7 | 8.2 | 10.6 | 11.6 | 12.3 |
| B19 | .0015" Al.Fl. | 48 | 174.8 | 171.9 | 8.0 | 10.3 | 10.9 | 12.1 |
| B20 | .0015" Al.Fl. | 72 | 202.5 | 199.9 | 8.1 | 10.4 | 10.8 | 11.2 |

APPENDIX B

Test 49-11

| No. | Wrapping Material | Wt. of Meat in Grams Original | Removed | No. | Wrapping Material | Wt. of Meat in Grams Original | Removed |
|---|---|---|---|---|---|---|---|
| 24 Hrs. | | | | | | | |
| 1 | .0015" | 280.5 | 277.2 | 21 | .0015" | 236.5 | 233.8 |
| 2 | .0010" | 346.5 | 342.7 | 22 | Cellophane | 270.6 | 266.4 |
| 3 | .0007" | 301.4 | 299.2 | 23 | .0007" | 252.5 | 250.0 |
| 4 | Cellophane | 316.5 | 312.3 | 24 | .0010" | 274.4 | 272.0 |
| 72 Hrs. | | | | | | | |
| 5 | .0015" | 154.6 | 152.6 | 25 | Cellophane | 163.5 | 160.1 |
| 6 | .0010" | 175.3 | 174.0 | 26 | .0007" | 230.5 | 227.2 |
| 7 | Cellophane | 162.5 | 161.0 | 27 | .0015" | 244.6 | 241.4 |
| 8 | .0007" | 116.5 | 115.0 | 28 | .0010" | 238.3 | 234.1 |
| 9 | .0010" | 296.0 | 293.3 | 29 | .0010" | 239.7 | 236.6 |
| 10 | .0015" | 253.1 | 249.7 | 30 | .0007" | 202.8 | 200.0 |
| 11 | Cellophane | 283.5 | 278.5 | 31 | Cellophane | 240.1 | 236.5 |
| 12 | .0007" | 294.8 | 291.2 | 32 | .0015" | 232.0 | 229.0 |

APPENDIX B- Continued

Test 49-11

| No. | Wrapping Material | Wt. of Meat in Grams Original | Wt. of Meat in Grams Removed | No. | Wrapping Material | Wt. of Meat in Grams Original | Wt. of Meat in Grams Removed |
|---|---|---|---|---|---|---|---|
| 48 Hrs. | | | | | | | |
| 13 | .0015" | 263.0 | 260.7 | 33 | .0007 | 252.6 | 249.3 |
| 14 | Cellophane | 322.4 | 318.7 | 34 | .0010" | 250.8 | 247.5 |
| 15 | .0007" | 286.5 | 284.4 | 35 | Cellophane | 214.2 | 210.7 |
| 16 | .0010" | 185.8 | 183.8 | 36 | .0015" | 239.8 | 236.4 |
| 17 | Cellophane | 296.4 | 288.8 | | | | |
| 18 | .0007" | 273.0 | 269.7 | | | | |
| 19 | .0010" | 240.1 | 236.5 | | | | |
| 20 | .0015" | 211.0 | 206.9 | | | | |

APPENDIX B -Continued (Group 49-11)

$$C.T. = \frac{(47.68)^2}{36} = 63.1495$$

$$\text{Total SS} = 67.8976 - C.T.$$

$$\text{Material SS} = \frac{(14.57)^2 + (12.10)^2 + (10.76)^2 + (10.25)^2}{9} - C.T.$$

$$\text{Periods SS} = \frac{(13.62)^2 + (16.01)^2 + (18.05)^2}{12} - C.T.$$

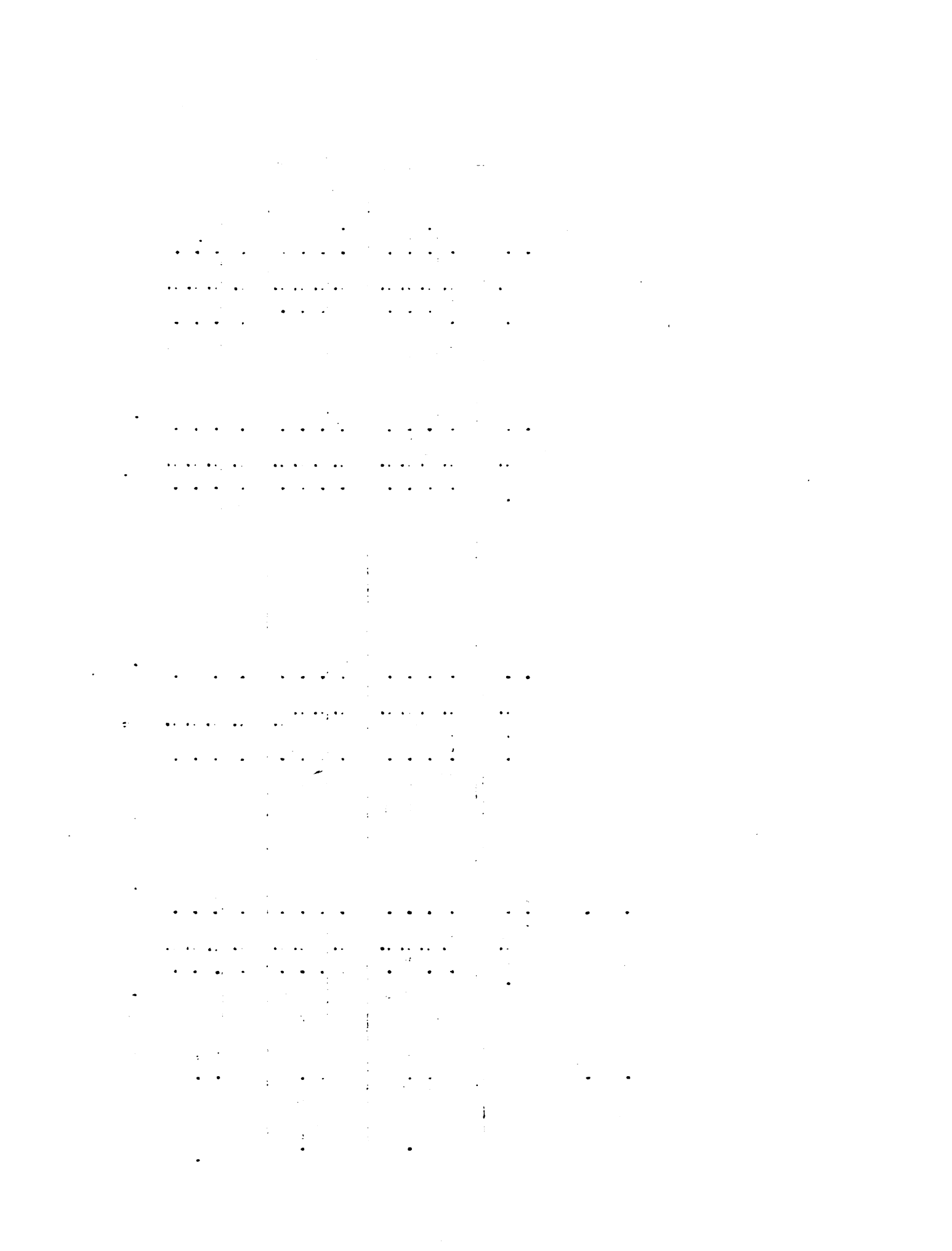
| Source | D F | S S | M S | F |
|---|---|---|---|---|
| Total | 35 | 4.6461 | | |
| Materials | 3 | 1.2432 | .4144 | 4.630** |
| Period | 2 | .7194 | .3597 | 4.019 * |
| Balance(Within) | 30 | 2.6835 | .0895 | |

** Highly Significant

* Significant

APPENDIX B - Continued (Test 49-11)

| | Cellophane | .0015" Al Foil | .0010" Al Foil | .0007" Al. Foil | | |
|---|---|---|---|---|---|---|
| 24 Hrs. | 1.32: 1.7424 | 1.07:1.1449 | 1.09 : 1.1881 | .72: .5184 | | |
| | .92: .8464 | 1.29:1.6641 | .74 : .5476 | 1.28:1.6384 | 13.62 | 1.1 |
| | 1.76: 3.0976 | 1.30:1.6900 | .91 : .8281 | 1.22:1.4884 | 16.3944 | |
| | 4.00: 5.6864 | 3.66:4.4990 | 2.74 : 2.5638 | 3.22:3.6452 | | |
| 48 Hrs. | 1.14:1.2996 | 1.40:1.9600 | 1.34 : 1.7956 | .73: .5329 | | |
| | 2.22:4.9284 | 1.94:3.7636 | 1.49: 2.2201 | 1.20:1.4400 | 16.01 | 1.3 |
| | 1.55:2.4025 | 1.14:1.2996 | .87: .7569 | .99 .9801 | 23.3793 | |
| | 4.91:8.6305 | 4.48:7.0232 | 3.70: 4.7726 | 2.92:2.9536 | | |
| 72 Hrs. | 2.07:4.2849 | 1.30:1.6900 | 1.72: 2.9584 | 1.43:2.0449 | | |
| | 1.49:2.2201 | 1.29:1.6641 | 1.29: 1.6641 | 1.38:1.9044 | 18.05 | 1.5 |
| | 2.10:4.4100 | 1.37:1.8769 | 1.31: 1.7161 | 1.30:1.6900 | 28.1239 | |
| | 5.66:10.9150 | 3.96:5.2310 | 4.32: 6.3386 | 4.11:5.6393 | | |
| | 14.57:25.2319 | 12.10:16.7532 | 10.76: 13.6750 | 10.25:12.2375 | | |
| | 1.6 | 1.34 | 1.2 | 1.14 | | |
| | | | | 47.68 | 47.68 | |
| | | | | 67.8976 | 67.8976 | |



# APPENDIX C

Boston Butt Slices

| No. | Hours | Wrapping Material | Cut Weight of Slice in Grams | Removed Weight of Slice in Grams |
|---|---|---|---|---|
| 1 | 48 | Cellophane | 228.8 | 222.7 |
| 2 | 48 | Al.Foil .0015" | 238.6 | 236.2 |
| 3 | 48 | Al.Foil .0010" | 208.9 | 205.0 |
| 4 | 48 | Al.Foil .0007" | 241.5 | 237.6 |
| 5 | 72 | Al.Foil .0007" | 269.5 | 265.7 |
| 6 | 72 | Al.Foil .0010" | 332.3 | 328.8 |
| 7 | 72 | Al.Foil .0015" | 299.6 | 294.5 |
| 8 | 72 | Cellophane | 255.7 | 249.8 |

# APPENDIX D

## Temperature of Display Cases on Three Different Days.

1949
Feb. 1

| Case | A | B | C | D | E | Case Average |
|---|---|---|---|---|---|---|
| 1 | 40 | 42 | 38 | 36 | 36 | 38.4 |
| 2 | 38 | 38 | 40 | 38 | 40 | 38.8 |
| 3 | 38 | 38 | 40 | 36 | 38 | 38.0 |
| 4 | 36 | 38 | 40 | 36 | 40 | 38.0 |
| 5 | 38 | 38 | 38 | 36 | 40 | 38.0 |
| Location Average | 38 | 38.8 | 39.2 | 36.4 | 38.8 | 38.2 |
| Feb.14 | | | | | | |
| 1 | 38 | 32 | 33 | 34 | 34 | 34.2 |
| 2 | 34 | 31 | 33 | 34 | 36 | 33.6 |
| 3 | 36 | 38 | 36 | 36 | 34 | 36.0 |
| 4 | 34 | 34 | 36 | 34 | 34 | 34.4 |
| 5 | 36 | 38 | 40 | 38 | 40 | 38.4 |
| | 35.6 | 34.6 | 35.6 | 35.2 | 35.6 | 35.3 |

APPENDIX D-Continued

1949
March 22

| Case | A | B | C | D | E | Case Average |
|---|---|---|---|---|---|---|
| 1 | 34 | 33 | | 32 | 32 | 32.7 |
| 2 | 34 | 35 | | 33 | 33 | 33.7 |
| 3 | 34 | 34 | | 38 | 36 | 35.5 |
| 4 | 36 | 38 | | 38 | 36 | 37.0 |
| 5 | 38 | 37 | | 34 | 34 | 35.7 |
| | 35.2 | 35.4 | | 35.0 | 34.2 | 34.9 |
| Average All Cases | 36.3 | 36.3 | 37.4 | 35.5 | 36.2 | 36.3 |

# APPENDIX E

## Test 49- M1

| Package No. | Hours in Display Case | Cut Weight in Grams | Wrapped Wt. in Grams | Removed Wt. in Grams |
|---|---|---|---|---|
| 1 | 72 | 198.4 | 197.8 | 189.0 |
| 2 | 24 | 199.5 | 198.7 | 194.8 |
| 3 | 72 | 214.8 | 214.1 | 206.1 |
| 4 | 48 | 246.0 | 245.6 | 237.0 |
| 5 | 72 | 215.6 | 215.4 | 207.8 |
| 6 | 48 | 199.6 | 199.4 | 192.5 |
| 7 | 48 | 192.7 | 192.4 | 185.8 |
| 8 | 24 | 200.0 | 199.7 | 193.4 |
| 9 | 24 | 213.2 | 213.0 | 209.1 |
| 10 | 48 | 226.7 | 226.5 | 219.6 |
| 11 | 24 | 229.8 | 229.5 | 223.2 |
| 12 | 72 | 207.1 | 206.8 | 199.4 |