ber of frozen locker plants offering freezer storage to the individual, together, have emphasized the need for more research in the field of frozen meat preservation. In order to meet this need a greater part of the research program on meat at the Kansas Agricultural Experiment Station has been devoted to this field of study for seceral years.

It was recognized early in the history of the frozen food industry that foods stored in the frozen condition tend to dry out rapidly unless well protected. Consequently there has been hwork done toward the improvement of wrapping materials. During the past few years, work has been in progress at this station on the relative merits of existing wrapping materials. The following objectives were sought: (1) Classification of the available materials according to the degree of moisture loss, measured by shrinkage in weight. (2) Direct comparison of the butcher and confectioners's styles of wrapping and, (3) Comparison of single and double wrapping.

Following are some of the conclusions:

1. Wax dip, aluminum foil, aluminum laminate and cellophane with stockinette and other wrapping materials of this type afforded a maximum protection against dehydration, permitting less than one-half of one percent loss in weight during 12 months storage.
2. The improved wax paper and glassine laminated paper provided adequate protection against dehydration for six to nine months, after which there is a marked increase in the rate of moisture loss.
3. The ordinary wax papers should not be used for storage periods exceeding three to four months. Ordinary kraft paper is not suitable as a wrapping material for frozen meat.
4. The confectioner's style of wrapping offers no advantage over the butcher style as far as protection against dehydration is concerned, if the wrapping materials is properly applied.
5. There is no practical advantage to double wrapping when using the ordinary wax or kraft papers. A single wrap, properly applied offers as much protection against moisture loss as double wrapping.

Other studies in progress at the present time include the influence of anti-oxidants fed to hogs upon the storage life of the fresh pork, and the methods of handling pork prior to storage upon the keeping quality of the fresh pork. Only slight difference in favor of the pork from hogs receiving the anti-oxidant have been noted to date, and then only after six to nine months storage. Likewise only slight differences favoring the rapid chilling of hog carcasses have been noted.

Additional observations from studies now in progress indicate that fresh pork, properly packaged can be stored satisfactorily for a period of six to nine months at 0°F. After six months storage there is a marked drop in the palatability of the product and a still greater drop after nine months storage. When the storage temperature is -10° F. or lower the quality of the pork is preserved for a longer period. Under present storage conditions it is recommended that all fresh frozen pork be consumed within six months or a maximum of nine months.

Project 260—Factors Influencing the Keeping Qualities and Nutritional Value of Frozen Meat.

SOME BACTERIAL OBSERVATIONS IN FROZEN PORK SAUSAGE PROGRESS REPORT—1948-49—Based in Part on Above Project

Robert L. Hendrickson

The preservation of food by freezing depends upon retarding the rate of microbial, enzymatic, and chemical changes. It is generally agreed that meat and meat products should be sharp-frozen at -10°F. (-23.3°C), and stored at 0°F. (-17.8°C) or lower to retard such changes. Work conducted by the Kansas Agricultural Experiment Station indicates that the quality of fresh pork is preserved for a longer period when frozen and stored at the lower temperature.

The general usage of locker plants by individual families, for the storage of perishable products such as meat, poultry, fruits and vegetables, represents one of the most recent developments in the field of food distribution and preservation.

The presence of micro-organisms in frozen meat may not be important from a pathogenic standpoint, but their presence may be influential in determining the storage life of meat or meat products. The presence of large numbers of bacteria may be due to the method of handling the meat prior to freezing, such as careless management or improper aging. It is a recognized fact that psychrophilic organisms will continue to multiply at chill room temperatures. High Bacterial counts in meat have raised a question in regard to the possible relationship of these micro-organisms to the keeping quality and storage life of the product. Since the locker industry has grown so rapidly, it was felt there is need for further study on the effect of the bacterial flora upon the quality of such meats when frozen. In this study fresh pork sausage was used to determine the influence of bacteria upon the keeping quality.

The sausage was made from fresh pork trimmings composed of approximately 75 percent lean and 25 percent fat, and seasoned with 1 pound salt, 2 ounces pepper, and 2 ounces sage for each 50 pounds of meat. This formula is recommended by the Kansas Agricultural Experiment Station. Four trays of trimmings were prepared and designated as M, N, O, and P. Each tray of trimmings was made from pork carcasses which were aged in the cooler for varying lengths of time. The aging period allowed time for the bacterial flora common to each carcass to multiply.

The four blocks of sausage were prepared and placed in a 34°F. cooler for 24 hours due to packaging. T series of one pound packages was made from each block of sausage, using cellophane (MSAT87) with an outer wrapping of wax paper as the protective covering. Each series was frozen in an air blast freezer and stored at 0°F.

A bacterial count was made of the seasoning ingredients used in order to determine how many bacteria were added to the meat by the ingredients. It has been found that nearly all of the common spices contain large numbers of bacteria. Platings were therefore made of the black pepper, sage, and salt used in this study. The counts indicated the presence of 2,000,000 bacteria per gram in black pepper, 27,000 per gram in sage and 10 per gram in salt. When these ingredients are used in the ratio of 1 gram of seasoning to one pound of meat as indicated in the above formula, pepper was found to contribute 30,000 bacteria per gram of meat, sage 60 per gram and salt less than 1 per gram.

A study was made of the packaging materials used to determine

what they may contribute to the sausage in the way of bacterial contamination. Contact plates made from the waxed paper showed the presence of 1 to 2 colonies per square inch. The cellophane had 2 colonies of mold per square inch in addition to 2 colonies of bacteria. The present methods used by paper manufacturers almost insure a sterile product. Therefore, it is evident that most any of the recommended locker wrapping materials are nearly free of bacteria.

A 50 gram sample was taken from each series at the time of packaging, after 24 hours in the freezer, 17 days storage, 28 days storage, and each 28 day period thereafter for 310 days. The sample to be used for bacterial plating was cut from the center of each one pound package with a sterile knife. By transferring the sample to a sterile petri dish it was possible to avoid further bacterial contamination. The specimen from each series was mixed in a wearing blender and plated immeriately for bacterial content. Difco's nutrient agar was used as the bacterial medium. It was found that sharp freezing does not materially decrease the bacterial content of the sausage. In fact, a slight increase in numbers was noted. This was thought to be due to two factors. Freezing of the ice crystals caused rupturing of the bacterial groups, thus breaking them into smaller fragments, and giving an increased number of colonies when the frozen sample was plated. It is also possible that some growth may have taken place during the freezing process. Unpublished data compiled at the Kansas Agricultural Experiment Station indicates that it requires 9 hours to completely freeze a two pound package of pork sausage in an air blast freezer at 0°F. This would seem to allow ample time for some growth to take place in the center of the package.

Experiments conducted elsewhere with garden peas and sweet corn showed that during rapid freezing, the water in the cells was not changed to ice crystals, but to a glass-like amorphous mass which resulted in less injury to the cell than when foods are frozen at a slower rate. Therefore, if slow freezing causes injury to the meat cells by the ice crystals, it may also break up the bacterial groups present, thus accounting for the slight increase in number of bacteria during freezing. A slower rate of freezing would also provide a greater opportunity for growth. These observations would seem to further justify rapid freezing. This potential growth period may be of considerable importance in the case of farm and home freezers or some locker plants where the rate of freezing is relatively slow.

Series M contained the largest number of organisms. The flora showed the evidence of some spore forming colonies, but the predominating organisms were of the non-sport forming type. This dominant type of organism was found to grow well at room temperature (70°F) but made little or no growth at body temperature (98°F). When a sample was allowed to remain in the chill room at 32°F. to 34°F. multiplication took place slowly after 24 hours. This organism is a non-spore forming, gram-negative, rod shaped psychrophilic organism. It has been reported that organisms of this description are common in fresh meat.

Observations from this study indicate that nearly 75 percent of the organisms naturally present die during the first two months of storage, after which the death rate for the remaining 25 percent is much slower. The vegetative and non-spore forming bacteria are most susceptible to low temperatures and therefore die early in the storage period. The spore formers being more resistant to freezing

were still present in large numbers after 310 days in storage.

Series N, O, and P contained relatively small numbers of the predominating organism, but about an equal amount of the spore forming colonies. Observations from this study indicate that during the 310 days storage period the total number of bacteria in the four series tended to become equalized, with the spore-forming type predominating at the end of the period. The bacteria added by the seasoning ingredients were of this type. This would seem to indicate that many of the spores were probably added during the seasoning and grinding process, and only a few spore forming organisms were actually present in the meat. The non-spore forming bacteria were found to die off more rapidly in the high count samples, than in the less populated samples, during the early part of the storage period. This was probably due to the presence of younger less resistant cells.

A portion of each pound package removed from storage was cooked and rated by a palatability committee. The scoring was based upon the following factors: color, texture, juiciness, flavor, and evidence of oxidation. The cooking samples were taken at the same time as the bacteriological sample in order to give a check on the quality.

The scoring showed a gradual loss of quality, but the difference between the four series is too small to be significant. It was unanimously agreed by the committee that series M, was the least desirable after 310 days storage. While the drop in palatability can not be attributed entirely to the influence of bacteria, it is belived that the presence of large numbers of bacteria may be a contributing factor in reducing the quality and shortening the storage life of fresh pork sausage. It is felt that a product with a higher initial bacterial count would have reflected a truer picture of the bacterial influence upon keeping quality. Sausage frequently contains much higher bacterial counts than were present in these samples. Sausage containing 25 to 100 million bacteria per gram might have given entirely different results. The study is being continued using sausage with higher bacterial count.

Miscellaneous Project

HOW MUCH MEAT FROM A STEER?

D. L. Mackintosh - R. W. Henrickson - D. B. Watt

How much meat should I have in my locker from a 1000 pound steer? This is the type of question that is asked most frequently by locker patrons. Many people, now using frozen food lockers have little conception of how much meat, the number of pieces, or the type of cuts that they should expect from one carcass. Neither do they realize what happents to a large part of a steer before reaching the locker. Actually a 1000 pound steer will yield approximately 180 pounds of steaks of varied kinds, 180 pounds of roast and pot roasts, and 90 pounds of stew and ground meat making a total of 450 pounds of table meat which is 45 percent of the live weight of the animal. A comparable shrinkage occurs when a hog or a lamb is butchered.

In order to familarize locker patrons with such facts, numerous studies have been made in the college meat laboratory and the resulting figures distributed where those who are interested may find them. The accompanying tables entitled "What Becomes of a Side of Beef?" "Suggested Breakdown of a Lamb Carcass," and "Suggested Breakdown of a Hog Carcass" are included here as a means of disseminating further this information. These tables are taken from class records at Kansas State College and are considered typical for each type of