METHODS FOR DETERMINING THE EFFECT OF FREEZING AND STORAGE ON TENDERNESS OF BEEF

P. A. Anderson
UNIVERSITY OF MINNESOTA

The history behind frozen food dates back a good many years, though many people at the present time believe the industry, as we know it, to be one of recent origin and development. Frozen foods in the manner of fish and meat probably date back a good many years in northern climates where these products could be weather frozen at certain periods of winter and their usefulness extended for a few months. The quality of the thawed product could be measured only by varied success and palatability.

It was natural from this beginning when mechanical refrigeration came into practice that low temperature storage came into use. This dates back about 100 years. Some attempts at low temperature freezing using brine and ice had been tried before this time. Tressler and Evers, in their 1943 edition, "The Freezing Preservation of Foods" record that the freezing of meat, more or less, was discovered by accident when the mechanical refrigeration installed in a ship used in transportation of meat from Australia to England developed mechanical trouble, or carelessness in supervision, and the entire shipment was frozen. The results were recorded as satisfactory, and freezing became a new part of the meat industry both for overseas shipment and domestic use.

Since that time, great advances have been made in mechanical equipment and in the processing and storing of food products. It is not for me to attempt to quote facts to this group of men as to the history of freezing, its rapid advancement and acceptance during recent years. I would say this, however, that the early standards of acceptance, as far as palatability is concerned, would not meet our present standards. We as a group know that our public have varied measures of acceptance of fresh meat on this basis. Many people have an idea they are eating Prime Grade meat when at best it would be just a Good Grade.

With this meager background, and without further elaboration, this paper has as its subject, "Methods of Determining the Effect of Freezing and Storage on Tenderness of Beef." To date, various workers in colleges and experiment stations have made numerous contributions of excellent merit showing original thought on this problem with not too much early data available. This is pioneering in a new field and many times with limited funds and equipment that today is like an old model car. A few of the packers and equipment companies, likewise, have performed experiments and, in many instances, have revealed some very helpful facts and knowledge.

It is my opinion that great strides have also been made by the locker people in the last few years by offering a more reliable service to their patrons. The early service was offered by many who had little experience in the processing of meat and very little thought was given to palatability of the product after it had been in a locker for some months. Many of the problems that were known by you men at that time have been more or less corrected.
and patrons are now showing a greater acceptance of services rendered. If the service offered has improved, a great deal of the credit is due to you men who have initiated many of the experiments covering this field.

We have had excellent results from many improved types and qualities of paper used. The styles or methods of wrapping have also improved. Cutting services have improved and patrons are, in many instances, getting the size and type of cut of meat suitable to their family. It is also noticeable that the slaughtering services have improved with more attention to pre-chilling and chilling of products. A meat product for satisfactory freezer storage must be in ideal condition for processing, as freezing is not going to improve the quality; and for moderately long storage, this becomes even of greater importance.

With this resume as a background, the following suggestions are offered as fundamentals to the setting up of experiments to test factors that are pertinent to determining quality and tenderness in beef by freezing.

1st I would endeavor to get steers or heifers by the same sire.

2nd I would get them as close as possible in age.

3rd All should be fed the same.

4th The age for slaughter should be the same; also live weight.

5th Methods of handling of carcasses should be the same.

6th At this point, I suggest the division of carcass. That is, one half to be aged in a normal way and the other for either a shorter or longer period.

7th Steaks or roasts for the study come from the same location of wholesale cuts, using paired methods.

(a) Methods of sharp freezing.

8th The style of wrapping might enter in for consideration as well as the kind and quality of paper.

9th Some consideration should be given to storage temperatures even though we are more or less agreed that temperatures of 0°F. are advisable and practical.

10th Setting the stage for number of days for aging and length of storage in freezer as influencing the tenderness.

11th Likewise, methods of thawing should be included because of palatability changes.

12th Definite tenderness tests, both mechanical and by cooking, are essential.

13th Setting up uniform testing or tasting board. Individuals who by previous testing have developed a keen sense of tenderness measuring where other factors are not involved.
14th Physical interpretation of structure of exterior of each cut used as to 1. fiber, 2. moisture, 3. marbling.

I realize that these suggestions cover an enormous field and could under no circumstances be carried out by one laboratory unless facilities of the highest order were available as well as an adequate staff.

There is another approach to this problem that I would suggest and that is to use a definite beef muscle that is large enough so that several samples may be obtained that are as similar in structure as possible. I have studied the work of Alice Child and co-workers who used the semitendinosus muscle for a meat study. There are several choices of unit beef muscles that may be used if cost of experimental material are not seriously considered.

In conclusion, I fully realize that some omissions have been made in what may be considered by others who have had more experience in the frozen food field than I have had. I do hope that some discussion can materialize from my suggestions which will lead to further studies in this field. I feel that there are still great opportunities to discover many things that have been unanswered up to the present time. As time goes on, progress will continue to be made along this line.

CHAIRMAN TOMBAVE: Thank you, Phil.

At this time I should like to introduce to this group, Mr. F. G. Ketner, of Ohio, who is Chairman of the National Live Stock and Meat Board and naturally very much interested in this group. Mr. Ketner.

The discussion leader on this very interesting paper is Charles H. Adams of the University of Nebraska.

MR. ADAMS: Mr. Chairman, we have all heard this interesting paper given by Mr. Anderson, dealing with the early history of freezing beef, or foods in particular, the influence of locker plants and their operation on the freezing of meats and his list of suggestions for setting up an experiment on frozen beef.

Is there any discussion? I know that a number of the institutions represented here have been doing work on frozen beef.

MR. PEARSON: I should like to make one comment. I think that Mr. Anderson's paper is very applicable to the subject and I think he covered it very well.

In going back over this matter of freezing temperatures I think that is very important. In the past I think we have put a lot of emphasis on temperatures and we have found a lot of differences. I think many of these differences could be explained on the basis of freezing rates rather than freezing temperatures actually, there being a difference there.

In a paper by Dan Brady, he suggested that we use freezing rates more frequently, and I think such a thing would be more worthy of
our investigation. With the use of the potentiometer and the thermocouple in getting our data, we will have freezing rates rather than merely freezing temperatures.

MR. ADAMS: That is a very good suggestion. I believe that you have been doing something like that down at Kansas State, with the use of thermocouples.

MR. MACKINTOSH: Not pertaining directly to tenderness but in some other work.

MR. KEMP: Mr. Anderson mentioned that uniform tasting and testing board. I should like any suggestions on how in any Animal Husbandry or Home Economics group you can obtain a tasting or testing board that will be uniform. We have done a little work and we have found that there is a great individual variation, and even if you use the same individuals they vary from time to time, too. So any suggestions on how that can be made more uniform would be welcome.

MR. ADAMS: Mr. Anderson, do you have any comments on setting up one of those boards?

MR. ANDERSON: I have no comments to make on it. I know there is a great variation, as you have said, and it has caused a lot of concern in conclusions to be drawn from a definite experiment. Of course, we have just one factor involved here on tenderness alone: what effect freezing has. I just offered that as a suggestion. I know that in some of the other foods that are being tested by various organizations they can divide these testing panels into particular groups that show sharpness for certain characteristics that may be desirable or undesirable in a food. That is the reason I made the statement. I have no suggestion.

MR. DETHERRAGE: Mr. Chairman, I should like to say that in the first place a subjective test should not be frowned upon for the mere reason that you get variation. You get variation in any biological study and so the fact that you do get variation ought not to be deplored at all. The important thing, however, is that you do get a sufficient number of samples. I have had experience with tenderness with at least three different groups of people. If the sampling and the cooking is properly carried out, the group are actually reproducible to a fraction of a score point. When I talk about a fraction of a score point I am meaning about 1/6th to 1/10th of a score point on any particular piece of meat. That is as good as any biological assay ever gets, and if done in sufficient numbers it can be carried out quite adequately.

We have used broiled steaks and if we have had a tasting panel consisting of six people, we have cut the steaks so that each individual could have two chances at tasting the same sample, thus getting twelve scores on a particular animal, and there was no question about the reproducibility and the usefulness, so long as you keep in mind that it is a biological assay and biological assays do have variation. In tenderness work we are at a particular advantage because tenderness is what the psychologists call "kinematics," which is much more easily measured than is flavor.
MR. LOEFFEL: I think one of the important things is to get an equal number of men and women on the panel. Inasmuch as the sexes are equally distributed, I think it is a good thing to have representatives of both sexes on the tasting panel.

One of the important things is to get folks who can be there with relative regularity. Selecting extension men is not a very good thing because they are not around often enough.

One of the things we did several years ago was to test the threshold of the judges. The psychologists tell us that there are four things that we can taste: Salt and sweetness, bitterness and acid. We mixed up a number of very dilute solutions, that is, graded solutions, and put them in test tubes, and we had these folks come in without any warning. First we had them rinse out their mouths with distilled water, and then we began to give them very dilute solutions of these different materials: Salt -- sodium chloride -- caffeine for bitterness, I believe, and acid -- I do not recall what the acid was. They said, "I taste something but I cannot tell what it is." Then we gave them the next higher dilution and they said, "Oh, yes, this is sweet," and that would be marked as the threshold of that person for that flavor. You will find that some people are very good for tasting acidity and they may not be very good for anything else. This method is very useful and it can be reproduced. The results can be reproduced, so that you can get some information about the reliability of your judges. One of the most unfortunate things about it, though, is that flavor of meat is tasted not by the taste buds but by the olfactory organ, that is, the aroma of the meat strikes our nasal sinuses. So this does not give you any clue as to how good a taster of meat you have. That is, from the strict sense of the word, because that is done by the olfactory organ.

MR. WARNER: I should like to ask Mr. Deatherage what he said the psychologists call "tenderness."

MR. DEATHERAGE: Well, I am not claiming that psychologists call tenderness that.

MR. WARNER: I know but what was the word?

MR. DEATHERAGE: It was "kinematics," that is, lifting and hoisting. You can tell the difference between 2 and 2.3 pounds, for example, or between 5 and 5.6. There is an increment of 10 per cent on the pressure sense, whereas flavor is a chemical sense and there is a slight variation there. There is not so much variation in tenderness and it can be measured quite as well as lifting weights, actually.

MR. HANKINS: Supplementing what Loeffel said about the threshold testing of individuals, I might say that we concluded from our work that judges with an intermediate threshold, as you might guess, were better than judges with a low threshold or a high threshold.

The other point that I should like to touch upon is that of sampling. As many of you know, we have done a good deal of work in this field, and were appreciative in the very beginning of the sampling problem or we thought we were. So we put the question to one of the
best statisticians that we had in the department at the time. We were setting up a permanent study of the effect on tenderness of four different freezing temperatures. Well, we wound up by using the two short loin cuts out of one steer. I think we had four steers all together, but one individual was used as a unit, and then we duplicated Nos. 2, 3 and 4.

Each short loin was divided into two parts and each part into four steaks or four samples, and four temperatures were distributed according to advice from the statistician. The four temperatures were distributed among those four samples, so that we had 4 and 4 and 4 or four different samples for each temperature coming out of this one steer, and then No. 2 steer, No. 3, and No. 4. We were pretty well satisfied with that. When we got through we were able to analyze the data. In fact, we handed the data to the statistician and said, "You analyze them" and we got some clear-cut results.

We are very fortunate in this animal field, in that every animal we have has two sides, and the corresponding samples that you take, left and right, are more nearly alike than any other two samples you will ever get hold of. We try to take full advantage of that in our work.

MR. BULL: You do not agree with the theory that a great many people have that one side is more tender than the other?

MR. HANKINS: I do not know how many years ago it is now that we gathered some data on the left and right legs of pigs and lambs and we proved that one side was more tender than the other side. Well, we did not tell anybody about it, and then we added some more data and we proved we were wrong the first time.

MR. BRADY: To come back to tenderness, what do you do on the threshold for tenderness? That is what I thought you were going to hit on.

MR. HANKINS: Well, I haven't anything to say.

MR. BRADY: We do not have anything that is comparable, do we? Who can determine tenderness and who cannot.

MR. HANKINS: I did not mean just to toss off the question. We think more of the objective methods than we do of the subjective when it comes to tenderness. We are pretty much inclined to throw the subjective out the window.

MR. DEATHERAGE: Mr. Chairman, I see that two friends have a little different point of view, and that is quite natural. I should say that the criterion for any test is its reproducibility, and I think there is no question that the subjective test is just as reproducible and just as reliable if properly conducted and it has to be conducted on a statistical basis.

Now to get to Dr. Brady's question, if he will come to Columbus, I can give him the history on every one of our taste panels including Larry Kunkle, Vern Cahill and myself. We can tell you just exactly how
reproducible those men are and it is quite remarkable. A person will reproduce himself within 1 point. In other words, if we have a tenderness scale of 10 he can reproduce himself within 1 point. With six people tasting in duplicate and reproducing themselves to that same degree your margin of error is very small. The question is, "Do you have honest tasters?" That is a big problem. Also, "Do you have tasters who are interested in the problem and are willing to give their time?" We have done a little promotion work at Ohio, and we have several people who are not even interested in meat tasting. We have the Home Economics and we have the Professor of Physiological Chemistry who does a lot of promotion work among the Graduate Council; we have the Dean of the Graduate School; and we also have a couple of expert dairy tasters. They are all very happy to co-operate and we get quite good results.

MR. ADAMS: I can understand why some of the dairy people would probably like to get some good meat once in a while.

MR. BRADY: Assuming that everybody in Ohio is honest and that it is not a problem, do you find that everybody can taste for tenderness?

MR. DEATHERAGE: No, not necessarily.

MR. BRADY: Who do you rule out and why?

MR. DEATHERAGE: I rule out anybody I catch trying to match pieces.

MR. BRADY: He is not being honest?

MR. DEATHERAGE: No, he is not.

MR. BRADY: But everybody who is honest then?

MR. DEATHERAGE: If they have not eaten enough meat to know what a tough piece of meat is and a tender piece is.

MR. ADAMS: You mean less tender.

MR. DEATHERAGE: This has been done. You can take an experienced taste panel and an inexperienced taste panel, and if you run a fair test, in other words, which piece is more tender, you will get the same results from the inexperienced panel as you will from the experienced panel. However, if you want to grade a piece of meat as to where it lies on the tenderness scale you have to have an experienced panel.

MR. Loeffel: I think one of the worst things we run into with a taste panel is just like with some of these judging teams -- people looking for things that are not there, and so many folks figuring that in order to earn an invitation to come back they have to find differences and they may be getting two cuts from the same roast.

Another thing that is very important on tenderness tasting particularly is the thickness of the slicing. You get one slice just a little thicker than the other and it is not going to be quite so tender as the thin slice.
MR. WANDERSTOCK: I just wonder if in your testing you standardize your judges first. Do you get your judges to decide whether a piece of meat is tender or less tender or do they just go right at it?

MR. DEATHERAGE: We have dry runs, so to speak, to see whether a person is able to reproduce himself and if they know whether a piece of meat is tough or tender. It would be just asking for trouble to take inexperienced people in.

MR. HANKINS: I do not want to leave the impression with this group that we do not use judges in judging our samples of meat. We do and we have those judges judge tenderness as well as other characteristics and we find agreement between the objective and the subjective. But whenever the question arises as to whether there is more error here or there, there is no question in our minds as to where the greater error is.

MR. BRATZLER: I should like to raise the question as to where Mr. Deatherage gets his homogeneous samples to begin with. That is one thing I have been looking for in testing, particularly for tenderness, that I can take one sample right adjoining the other and know that they are exactly the same.

MR. DEATHERAGE: Well, I think the very essence of any testing method or any biological method is that we admit variation and take enough samples to block it out.

MR. ADAMS: I believe we have probably used up our time on this.

CHAIRMAN TOMHAVE: Thank you very much, Mr. Adams.

The next topic is along similar lines, "Methods Used in Determining the Effect of Freezing and Storage on the Keeping Qualities and Nutritive Value of Pork," by Professor R. L. Hendrickson of West Virginia University.

# # #