One phase of the research program on meat tenderness at the American Meat Institute Foundation is directed toward determining the optimum environmental aging conditions for the rapid tenderization of beef. Because the increased tenderness achieved during aging is largely, if not entirely, dependent on the endogenous enzymes in the meat it may be assumed that the aging process can be accelerated by raising the temperature of holding. Until the advent of antibiotics and irradiation, there was no practical means of investigating aging at elevated temperatures.

In our work, we have chosen three temperatures of aging, 60° F., 90° F., and 110° F., and we wish to determine the optimum time for aging at each of these temperatures. Antibiotics have been employed as the principal bacteriostatic agent, but more recently we have used gamma irradiation both alone, and in combination with antibiotics.

In our initial trials at 60° F., chilled intact rounds were artery and stitch pumped with 20 to 100 p.p.m. of antibiotic and the surface dressed with the same antibiotic or a chemical agent such as sorbic acid. While this procedure was effective in controlling microbial growth at 60° F., the variability in tenderness between animals, sides, muscles, and within muscles precluded an accurate evaluation of the changes taking place during holding. At least this is true for studies that we were making.

This led to the use of steaks cut from the top round, which permitted randomization of the steaks with respect to animal, side, and muscle location. In using antibiotics, the top round was stitch pumped prior to the removal of the steaks. Each steak was then packaged in Cry-O-Vac and allotted to a particular treatment. Vacuum packaging reduced the need for a surface dressing since most of the antibiotic resistant flora consisted of yeasts and molds that are obligate aerobes. U. S. Utility grade cow rounds have been used for the experimental work. These were received and pumped with antibiotic 48 to 72 hours post mortem.

Steaks held at 35° F. for five days were slightly more tender than they were prior to aging. This was also true of steaks held at 60°, but not until the seventh day of aging was the increase in tenderness in steaks held at 60° F. significantly greater than the increase in tenderness in steaks held at 35° F. These results were obtained on eight rounds, and the increases in tenderness was not marked, but the data indicate that for U. S. Utility grade rounds, the optimum aging time at 60° F. is at least greater than five days.

Results from experiments using 90° F. as the aging temperature have been limited since antibiotic alone in concentrations up to 100 p.p.m. was
insufficient to control microbial growth for more than one day. After one day of aging, the increase in tenderness at 90°F was not significantly greater than the increase at 35°F. The combined effect of 20 p.p.m. of antibiotic and gamma irradiation has permitted the holding of steaks at 90°F for four days. The initial trials using the facilities at the Argonne National Laboratory were used primarily to investigate microbiological control, and the effect of the procedures used on other qualities of the meat and the steaks were not evaluated for tenderness. A level of gamma irradiation much higher than the 200,000 rep used in these experiments would permit still longer aging times at this temperature, but as research elsewhere points out would exaggerate the slight off flavors noted at 200,000 rep. Because of this limitation, it appears that four days is about the maximum time steaks could be aged at 90°F.

Microbiological growth was more readily controlled at 110°F than at 90°F when antibiotics were employed as the only bacteriostatic agent. Tenderizing effects at this temperature have been variable. In an initial experiment, 24 hours aging at 110°F had a pronounced effect on tenderness. In a later experiment, there was no apparent increase in tenderness after 40 hours. Studies are being continued to more accurately evaluate this aging temperature.

The experimental aging of beef at elevated temperatures requires a careful examination of the product prior to serving it to a taste panel. In these experiments, portions of the aged beef are removed and analyzed for total aerobic population, population capable of anaerobic growth, and the presence of toxigenic staphylococci. Samples are considered to be unacceptable for organoleptic testing when the anaerobic count is in excess of 300,000 per gram, or if microscopic examination of any colonies picked from the recovery medium shows gram positive rods. In addition, if there is any evidence of staphylococcal growth, using the tellurite glycine medium of Zebovitz, Evans and Niven as the criterion, the meat is discarded.

Possible toxin production during aging is tested by inoculating mice with a suitable dilution of a water extract of the aged steaks. (A report of work done under contract with the U.S. Department of Agriculture and authorized under the Research and Marketing Act of 1946. The contract is being supervised by the Eastern Utilization Research and Development Division of the Agricultural Research Service.)

DR. HENRIKSON: Thank you, George. It is interesting to see how rapidly we are speeding up everything else. We might just as well speed up this business of aging and get it done in 24 hours.

We had another topic which we felt should be discussed this morning, but in arranging the program we found that it was difficult to get it in the two-hour period. However, we have asked Dr. Hiner to
lead the discussion period and, if he will, we should like to have him say a few words about the influence of breeding on tenderness. Maybe this is on the spur of the moment, R. L., but if you will we will appreciate it.

DR. R. L. HINER: Mr. Chairman and Members of the Reciprocal Meat Conference: I had intended to mention the fact that nobody in the group had brought up the point that there is a possibility that heredity may be a factor in this tenderness and it is being overlooked a little this morning. We have been doing a little investigation work along this line, and now at present we are trying to develop a satisfactory method by which we can tell how tender a live animal is. So far our results have not been too encouraging.

Of course, we are using a biopsy sample. We have used fiber diameter as one of our measures, and we are also using a mechanical shear, trying to develop something there that we can take a small sample from the round. We have been using the semitendinosus muscle. In a brief review of this, I was interested in the methods that Dr. Schultz reviewed. I might say that I had an interesting experience in the past month. There was a man from England, from the low temperature laboratory there, who spent a couple of hours with me one day. He was talking about a tenderness machine that has recently been developed in Germany. Apparently, it has a little different principle than what most of them have been working with here. It is an all-handmade job. They have obtained one of the instruments. I believe there are only three of four of them available. They cost something like $1,000, and they are supposed to be the last word. He didn't know too many of the particulars. He is going to get them and send them to me when he gets back home.

I think that we have probably covered all of the different procedures that we are using in trying to determine tenderness. We have been trying to see what we can get out of hydroxyproline. We have run into a lot of difficulties, and so far we are not too happy with the results. However, we are still going to continue to see if we cannot modify it and possibly obtain something.

We are very much interested in the fat problem with relation to tenderness. I have an entirely different feeling toward the problem than Dr. Deatherage has expressed. I feel that it requires a certain amount of fat. However, I think we have to think of fat in terms of the liposome body probably within the fat itself more than the fat on the outside of the animal, and I have an histologist who is now working on this angle of it.

I might say that some of these other methods, such as the use of enzymes in tenderizing, are all very interesting. However, I have never failed to sample one that didn't have an after-effect of flavor that I did not particularly desire. I don't know, but if they could get that out of it, it might be all right. This idea of aging at high temperatures, rapid aging, may be all right, too.

Now I believe I will throw it open to questions that anybody might want to ask, and we will see if we can get some controversy. Does
anybody have questions that he would like to ask of any of these five men?

MR. FLOYD CARROLL (University of California): I should like to ask, Dr. Wilson, about how much shrinkage do you get from aging at really high temperatures, say 110 as compared with 60?

DR. WILSON: We are aging these in Cry-O-Vac bags and they are aged as steaks. So what I say would not necessarily be applicable if you were aging a round. By this procedure we get a greater shrinkage during the aging period but much of that is made up in the cooking. In other words, they lose pretty close to a constant amount of juice whether they are aged at 35 or 110. It is a matter of where that juice is lost. One is lost during aging and the other is lost during cooking.

DR. HENRICKSON: I should like to ask George if in putting it in the Cry-O-Vac bags he draws a vacuum on them.

DR. WILSON: Yes, we do.

DR. HENRICKSON: If you do draw, say a high vacuum, do you anticipate that will reduce the amount of enzymatic activity, the oxygen starvation there?

DR. WILSON: No. The way we look on that is that you are making that steak much like it would be inside the round as you can. I mean I know of no evidence for this. I have heard, as I am sure a good many of you have, about oxygen starvation during aging. I don't subscribe to it myself until proven otherwise.

DR. HENRICKSON: The question I had was, if you took away all the oxygen, would the enzyme systems continue to break down the protein material?

DR. WILSON: If they will function in the center of the round they should function in the Cry-O-Vac bag.

DR. HINER: You get a sort of vacuum in the center of the round, a condition comparable to a vacuum?

DR. WILSON: Yes.

MR. E. J. BRISKEY (University of Wisconsin): I should like to ask, Dr. Deatherage, first of all in comparing two samples of widely differing tenderness, for your comments on the relationship of the total cation exchange in comparison with the shift and, second, if you found any differences in total strength concentration in the two samples of that nature.

DR. DEATHERAGE: Well, I would say that we don't have enough data to take the correlation of values between tenderness and, for example, the amount of sodium that happens to be in one fraction and another amount in another fraction. There was one slide, whether you
remember it or not, that gave the range of values of the total amount of ash - I mean the total amount of these ions. An animal can’t live outside about plus or minus 10 per cent of its normal osmotic pressure, and actually the total amount of ion is pretty well regulated within 10 per cent of the mean. So I cannot answer your question any more than that.

DR. HINER: Any other questions?

There is one question about the excess of 4 per cent shrink in some of these animals that Mr. Sleeth reported. Isn't that a rather high shrinkage?

MR. SLEETH: I just used that as an example. Our normal shrink has been around what we reported on the other slides - about 2 per cent.

DR. HINER: You don't have any explanation for that? Is it a function of relative humidity?

MR. SLEETH: Yes, the shrinkage certainly is correlated with the amount of relative humidity you have in the cooler. The higher the relative humidity the lower the shrink. We have shown that in several tests.

DR. HINER: I believe I will turn the meeting over to the Chairman, if there are no other questions.

DR. HENRICKSON: We are already running past our time but I should like to say before I turn it back to Tom that it has been a real pleasure for me to work with this committee. They responded very quickly to our requests. Also it has certainly been a pleasure to work with the Executive Committee, Tom. Thank you.

CHAIRMAN BLUMER: Thank you, Bob, for a job well done, and the members of your committee. We certainly appreciate it.

In the interest of time we will dispense with any other reported and you will return at 1:15. It is now 12:15. I think we cannot cut it any shorter than that because there are some committee meetings and I know that some of you have room arrangements to make. But please be back at 1:15.

(The meeting recessed at 12:15 o’clock.)