

MEAT QUALITY RESEARCH

Dr. Louis Feinstein  
Field Crops & Animal Products Research Branch  
Market Quality Research Division  
Agricultural Research Service  
United States Department of Agriculture  
Hyattsville, Maryland

D-1

ABSTRACT

Since evaluation of the market quality of livestock and meat is a complex problem, factors influencing palatability, flavor, maturity, marbling, and shelf-life are first discussed. This is followed up with a short description and a statement of findings of four meat quality research studies: The use of gamma-and beta-radioactivity as a means of determining meat composition; anesthesia as a method for determining body composition of the live meat animal; a detailed study of the factors influencing quality in pork; and a study of the influence of bovine age upon the characteristics of meat and carcass grade. In the conclusion are listed the seven important objectives of the meat quality research program now being undertaken by the Field Crops and Animal Products Research Branch, Market Quality Research Division, of the United States Department of Agriculture.

## FLEISCHQUALITÄTSFORSCHUNG

Dr. Louis Feinstein  
Field Crops & Animal Products Research Branch  
Market Quality Research Division  
Agricultural Research Service  
United States Department of Agriculture  
Hyattsville, Maryland

### ABSTRAKT

Da die Bewertung der Schlacht- und Fleischqualität landwirtschaftlicher Nutztiere ein kompliziertes Problem ist, werden zuerst die Faktoren besprochen welche Schmackhaftigkeit, Aroma, Reife, Marmorierung, und Haltungsdauer des Fleisches beeinflussen. Es folgt eine Aufzeichnung und kurze Beschreibung der Resultate von vier Fleischqualitätsstudien: Verwendung von gamma- und beta-Radioaktivität als Mittel zur Bestimmung der Fleischzusammensetzung; Anästhetisierung als Methode zur Bestimmung der Körperzusammensetzung am lebenden Tier; eingehendes Studium qualitätsbeeinflussender Faktoren beim Schweinefleisch; und viertens Einfluss des Lebensalters auf Schlacht- und Fleischqualität beim Rind. In der Zusammenfassung sind die sieben Hauptziele derzeitiger Fleischqualitätsstudien des Field Crops and Animal Products Research Branch, des Market Quality Research Division, des United States Department of Agriculture aufgezeichnet.

MEAT QUALITY RESEARCH  
Dr. Louis Feinstein  
Field Crops & Animal Products Research Branch  
Market Quality Research Division  
Agricultural Research Service  
United States Department of Agriculture  
Hyattsville, Maryland

Livestock and meat are commodities which vary considerably in those attributes which determine their market value. Evaluation of the market quality of livestock and meat is a complex problem, but the development of adequate objective methods of quality evaluation would have wide application in the meat industry. We need improved methods for measuring the proportion and distribution of lean and fat present in meat, as well as objective methods for color, texture, and firmness. Flavor is an important meat quality characteristic, but is only indirectly judged by current grading procedures. Palatability characteristics, such as maturity and marbling, are not necessarily firm indicators of flavor. The solution to the flavor problem requires a basic understanding of the precursor systems, the optimum conditions for the production of flavor, and the identification of the flavor compounds.

Maturity, one of the most important factors in establishing grades for carcass beef, is usually evaluated by visual evidences of physiological age in the carcass or cuts. These include degree of ossification of the bones and cartilages, texture, and color of the lean meat. Recent evidence suggest that not all of these factors may give the same assessment of physiological maturity. Since muscles develop at different rates, the use of one muscle, such as the longissimus dorsi, as a yardstick to evaluate the maturity of a carcass may be an inadequate guide to the overall maturity of the carcass. Considerable interest in determining the changes in muscular components during the development of the animals and the effect of ante-and post-mortem handling practices on these components has recently been in evidence in the meats field. Marbling, also considered an important factor in establishing grades for carcass beef, may well be a reflection of total lipid concentrations, but it is not necessarily a direct measure. Thus the interrelationships that exist between marbling and the composition, concentration, and distribution of phospholipids, triglycerides, and unsaponifiable lipid material in muscle may prove more significant in the evaluation of palatability characteristics than marbling alone.

An increase in shelf-life of fresh meat of only a few days would decrease wastage, improve consumer satisfaction, and increase the flexibility of meat marketing procedures. Progress has been made in the transportation of refrigerated fresh meat, but present systems still fall short of need in assuring uniform low temperatures at low cost. Integrated research under controlled conditions is needed to evaluate the influence of marketing practices upon the shelf-life of the packaged product.

The United States Department of Agriculture has carried on market quality research in the above areas by cooperative agreements, by contracts, and by its own efforts. I would like to bring to your attention some of the results of past research at this time and then close by indicating the direction of our present and future quality research.

We have worked very closely with the Animal Husbandry Research Division of the Department in a number of radioactivity studies. One of the early studies involving gamma measurements of intact hams revealed a highly significant relation between net counts per minute from potassium -40 and pounds of separable lean. A study was made later of the relation between the low level of gamma-ray radiation emitted and the composition of beef rounds. A highly significant negative correlation between the percent of separable fat and disintegrations per minute from  $K^{40}$  per pound of intact round was found in this study. The correlation of percent separable lean with disintegrations per minute from potassium -40 per pound of intact round was also highly significant. The results of a study in which measurements were made of the beta radioactivity emitted by the ash of ham fat trimmings gave evidence of a relationship between the amount of beta radioactivity emitted, expressed on a fresh weight basis, and the percent of fat-free lean (fresh basis). Data also was obtained in regard to the correlation of beta radioactivity and the content of ether extract, protein, and moisture in these samples.

A few years ago, I was interested in finding a method for determining fat directly in the living intact meat animal. The method had to be quick and as accurate as possible yet done with as little effort as possible. Anesthesia appeared to be a lead. It would only be necessary to inject the sleep-causing chemical and count the minutes of slumber. No blood samples would have to be taken and no blood samples would have to be analyzed. I undertook using a small herd to determine the validity of using the anesthetic induced sleep time of an individual hog to predict carcass fat or carcass lean. Later, Dr. Hiner of the Animal Husbandry Research Division and I made a more detailed study. Fifty-seven crossbred hogs which came from various feeding experiments were used in this study. Each animal was used many times and a growth weight curve was obtained on each animal to be certain that each was growing normally from weaning to final slaughter. The anesthetic induced sleep times of the thiobarbiturates, compound 1, sodium 5-ethyl-5-(1-methylbutyl)-2-thiobarbiturate, and compound 2, sodium 5-allyl-5-(2-cyclohexenyl)-2-thiobarbiturate, were evaluated. All the correlations of compound 1 were below 0.19. We found compound 2 was effective in estimating body fat and lean when injected approximately one month rather than two months before slaughter. Sleep time was more effective, however, in estimating the fat and lean content of the ham approximately two months rather than one month before slaughter. The data indicated that more

experimentation is needed to determine the usefulness of sleep time to estimate carcass fat or lean. Although sleep time is a promising measure of fat and lean in the carcass, the factors affecting the reliability of this measure need more experimentation.

The University of Wisconsin under a contract made a study for us on the factors influencing quality in pork using a total of 466 carcasses selected for this study and included animals of known and unknown histories. Five different visual gradations of intramuscular fat (marbling) in the longissimus dorsi muscle, and four different carcass weight groups were used for the 20 categories included in the unknown history groups. Five marbling scores and five age groups accounted for the selection of the 25 known history groups. The number of animals included in the analysis was 332 butchers and 107 packer-type (sow) carcasses. Fresh loins and hams, cured hams, and bacon were evaluated subjectively and objectively for palatability characteristics.

Marbling in the longissimus dorsi and chronological age were found to be the most important factors associated with palatability. Fresh pork loins were generally acceptable in palatability if they contained approximately 20% of intramuscular fat on the moisture free basis. When pH and weight of the loins were held constant, there was no difference in palatability due to intensity of the color of the longissimus dorsi muscle. The palatability of commercially cured hams was acceptable regardless of chronological age, carcass weight, or intramuscular fat content. An increase in tenderness of bacon was associated with an increase in intramuscular fat content of the longissimus dorsi muscle. Flavor and juiciness of bacon were not affected by differences in chronological age, carcass weight, or intramuscular fat content of the longissimus dorsi muscle. The pH values of chilled, aged, and cooked muscles were highly correlated.

Protein content of pork muscle was not associated with palatability or overall carcass leanness, but increased amounts of protein were related to higher cooking yields. The protein/moisture ratio was constant for carcasses representing various ages and degree of fatness, yet the correlation between protein and moisture was low. Total connective tissue and three of four collagenic components studied, were not related to the chronological age of the samples evaluated. The longissimus dorsi muscle contained about 0.68% (fresh basis) connective tissue and the average elastin/collagen ratio was 0.75. Weak alkali and acid soluble collagen represented about 10% of total collagen. The insoluble connective tissue components varied together; however, the change in quantities of the acid and alkali soluble fractions were independent of each other.

Oklahoma State University also under contract made a study of the influence of bovine age upon the characteristics of meat and carcass grade. Eighty-five Hereford steers and females were used. All animals were selected from

a large population herd to fit the 6-, 18-, 42-, or 90-month age groups. In many cases, selections were made one to three years in advance of the slaughter date. It was not feasible to select all animals in any one year, since this would have jeopardized the existing breeding and management studies. Consequently, desirable animals were utilized as they became available. Since all animals were of similar genetic and management background, they were further confined to a similar ration when feasible. Each selected animal was group fed in an attempt to provide a carcass with one of the desired marbling levels required and still be within 10 percent of the desired age at time of slaughter. Some of our research findings were: The influence of age on tenderness may not be as great as has been commonly thought, but that the tenderizing effect of aging beef may be greater for the younger animals than for older ones. The association of marbling with tenderness varied with animal age. Increased marbling did not enhance the tenderness of 18-month old animals; however, it was related to an increase in tenderness from 42- and 90-month age groups. Animals 18 months or younger were very tender while those 42 months or older were approaching the slightly tough side.

The meat quality research efforts for the next few years have the following objectives:

1. To devise and develop improved methods for maintaining meat quality in market channels during handling, packaging, and transporting operations.
2. To study the effect of atmospheres with various concentrations of added carbon dioxide or nitrogen upon the properties of refrigerated meat.
3. To devise and develop accurate methods for estimating the market quality of livestock and meat as an aid to marketing operations.
4. To characterize the present lighting conditions under which meat is graded, to conduct laboratory tests to determine the effect of lighting conditions on the evaluation of meat quality characteristics, and to evaluate the results of the laboratory findings in beef coolers using experienced and unexperienced evaluation panels to determine meat quality characteristics and recommend specific lighting requirements for grading if justified by the results.
5. To develop objective procedures for identifying and evaluating flavor characteristics of meat by studying the compounds and reactions responsible for meat flavor.
6. To provide objective maturity evaluation factors for grading meat by a study of the qualitative and quantitative relationships that exist between nitrogenous, carbohydrate, and electrolytic carcass components and maturity.

7. To develop an improved procedure for the evaluation of beef palatability by studying the relationships between marbling, lipid composition, and palatability.

In carrying out research to obtain the above objectives, we in Marketing Research are working closely with others in the Department who are doing production and utilization research. In addition, we have a research contract with the University of Missouri to obtain information covering our first objective, maintaining quality of meat during distribution. Under a P.L. 480 Grant at the Meat Research Laboratory at Hameenlinna, Finland, research is underway on our second objective, the effect of carbon dioxide and nitrogen atmospheres on the behavior of meat under refrigeration.